POWER

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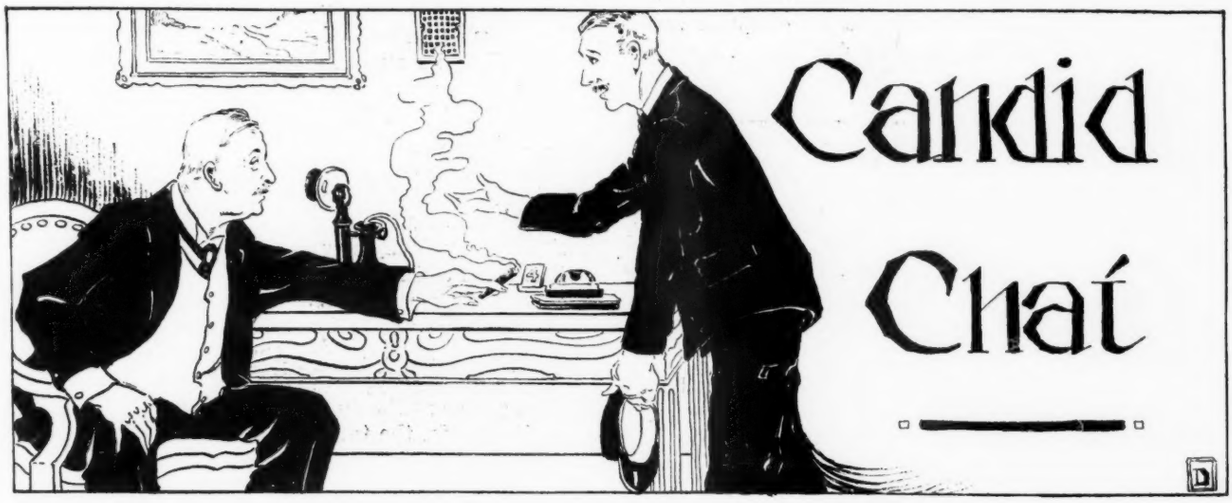


Setting the Boss Straight

By J. O. Batzer

With a pleasant, "Good morning, sir," the chief engineer entered the luxurious office occupied by the president of the great corporation. The day was dark and cold, and the cozy comfort of a properly heated and lighted room contrasted pleasantly with the gloom outside.

"How do you do, chief," the president responded. "What is your trouble today?"

"None at all," the engineer answered. "I only wanted to see whether you were comfortable this morning."

"Thank you. My office seems very agreeable. How are things going down in your plant this weather?"

"Very smoothly," said the engineer. "If they weren't, you'd quickly discover the fact."

"Yes, if your boilers should blow up or your engines break down, I presume that I would hear about it," the president remarked jocosely.

The engineer, who during the number of years the plant had been in operation had never had the honor of a personal inspection of his domain by the "big boss," thought the time opportune to give the president a better understanding of the importance of the plant service, so he replied:

"Yes, you would undoubtedly hear about it; but such a calamity would not be required to spoil the comfort of your office. A little slip or inattention on the part of one of the lowest paid plant employees would be sufficient to ruffle your feelings and interfere with your important work."

The president looked interested.

"Chief," he said, "I must admit that I am unfamiliar with the details of your plant, but I also am unconscious that my peace of mind depends solely on the successful operation of your plant."

The engineer hesitated for a moment, looking around the room. The lights were bright and clear, indicating that the steam pressure was up to the notch to keep the overloaded units generating current at the required voltage. Small flags fluttered from the ventilating registers in the steady current of heated, washed and humidified air, while the smoke from the president's cigar whirled in a blue streak through the exhaust duct on the wall. The engineer smiled.

"During the years this plant has been in operation," he said, "did you ever find the elevators refuse to give you instant service?"

"No."

"Did not these push-buttons always furnish you the desired illumination?"

"They surely did."

"You never once in all these years stepped out to your lavatory to find the faucets unresponsive to your push for hot or cold water; the drinking fountain in your office bubbles cheerfully with clear, sterilized and refrigerated water; the fan systems are faithfully pumping into your room an abundance of clean, washed air with the most healthful degree of humidity, while the used air is drawn out through those registers. If you examine the recording thermometer over there, you will find that in spite of the variation of outside temperature, it shows a practically true and unbroken circle for the whole week. Are not every one of these things very essential to your comfort?"

"Yes, chief, I admit all that."

"The complex system required," the engineer continued, "for the production of all these apparently insignificant but necessary details is rather difficult to grasp; but a shutdown of even a part of the system for the shortest duration would be detrimental to your ease and comfort."

"True enough," the president remarked, "but your modern, expensive plant ought to insure continuous service without such absolute dependence on the operating force. The automatic features of an up-to date plant like ours should relieve the engineer of a great amount of work."

"But you must remember," the chief engineer retorted, "that the modern plant is dependent to a far greater degree than ever before on the unceasing attention of the operators. A plant equipped with a multitude of automatic devices does not function very long without the controlling human element. Modern mechanical developments do not eliminate labor, but elevate it to a position where it must display skill and knowledge."

The president looked out of the window in silence for a moment. Then he turned to his visitor. "Chief, your talk was very interesting. No doubt the years of splendid service of your plant have made us forget the importance of the faithful attention you and your men have given. At the first opportunity I am going to visit the plant and learn more about it."

The chief could not hide his satisfaction at this announcement.

"We shall welcome your visit," he assured the president, "even if it is only an annual inspection, for your personal interest will be a spur to greater effort for efficiency. More than that, it will make us feel that we are not buried and forgotten, but that we also are vital parts of your great organization."

Armour's Special Testing Equipment

Ingenious apparatus of unusual design for determining directly the horsepower of automobile engines, the influence of impact, bearing friction, belt slippage and heat flow through any material that can be prepared in flat slabs. Other interesting equipment at the Insitute includes a ***boiler-room control board and at complete ice-****making plant with facilities for measuring all heat exchanges.*

THE Research Committee of the American Society of Mechanical Enginees has inaugurated recently several activities tending toward the better use of facilities available in the laboratories of the various technical schools, universities, large industries and

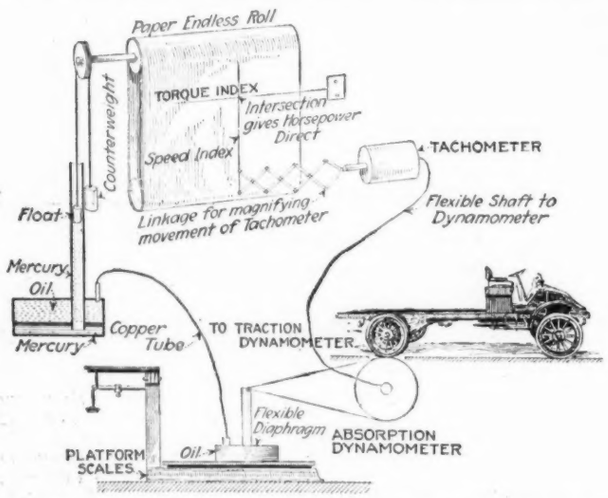


FIG. 1. DIAGRAM OF DIRECT-READING HORSEPOWER METER

private investigators. One of the objects is to avoid duplication by publishing results of tests of value to the profession that have been conducted and by giving notice of interesting work to be undertaken. It is acknowledged that the equipments of certain laboratories are specially fitted for definite kinds of research, and if it were known what each had in the way of special equipment, problems would naturally go to those laboratories best fitted for the work. A survey of laboratory facilities is the first essential, and in this connection the following outlines of special testing equipment obtained from Prof. G. F. Gebhardt, of the Armour Institute of Technology, Chicago, may be of interest.

Horsepower Meter—One of the most ingenious and useful of the various testing outfits in the gas-engine laboratory is the horsepower meter shown diagrammatically in Fig. 1. This apparatus enables the driver of a chassis to determine the traction effort and the horsepower delivered to the rear wheels at any instant without the need of calculation. The chassis is backed up on the test platform so that the rear wheels engage with corresponding pulleys of an absorption dynamometer and the frame of the vehicle is attached to an indicating traction dynamometer. The driver then needs only to drive the machine at various speeds, and the traction effort and horsepower developed at the rear wheels are automatically indicated by the mechanism of the meter.

Referring to Fig. 1, rotation of the rear tires is transmitted to the two large-diameter wheels of the dynamometer. The brake load on the dynamometer arm is transmitted through a copper tube from an oil-filled chamber on a platform scale to an oil reservoir, as indicated. The oil pressure, through the agency of a mercury column, actuates a balanced float, the movement of which is transmitted to an endless roll of paper. The displacement of the paper roll is a direct measure of the torque since the brake arm is of constant length. The brake is of the Alden dynamometer type, and the load required to absorb the power is controlled hydraulically from any convenient point.

The speed of the dynamometer is transmitted through flexible shafting to a special tachometer so arranged that the index needle moves axially across the paper drum. The intersection of the tachometer index with that of the torque index gives the horsepower directly. Thus a glance at the meter proper gives the load on the scale in pounds, the torque in foot-pounds, the speed of the dynamometer in revolutions per minute and the horsepower developed at the rear wheels. The scale

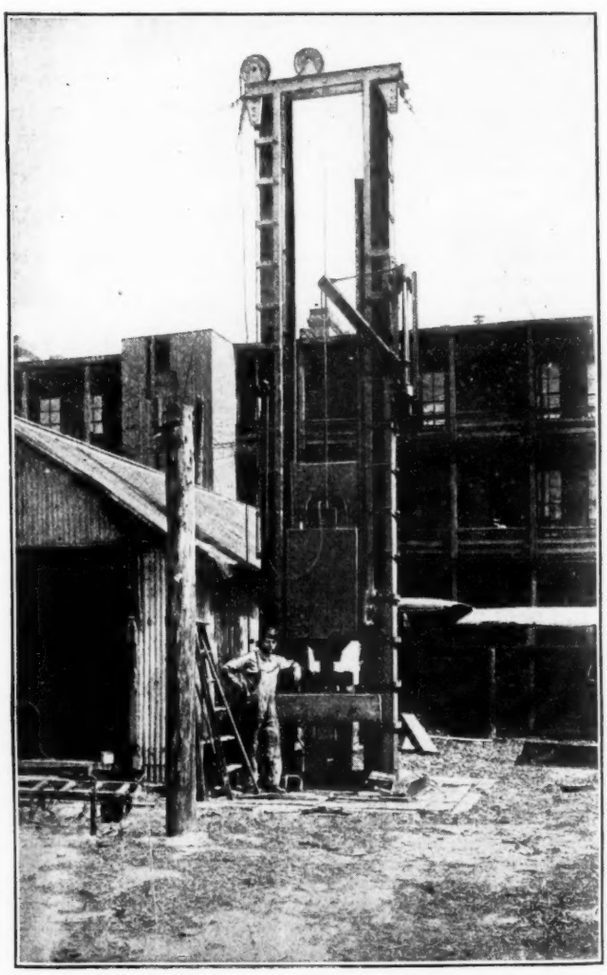


FIG. 2. IMPACT MACHINE WITH 9000-LB. TUP

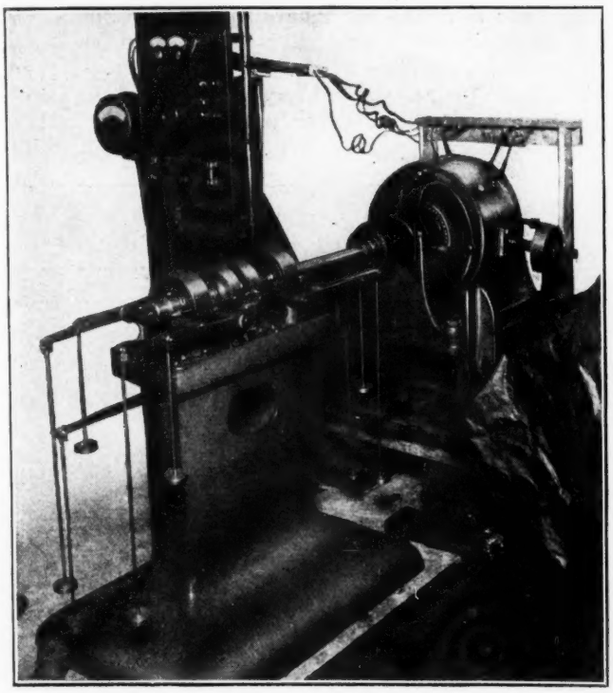


FIG. 3. BALL-BEARING FRICTION TESTING MACHINE

beam offers a check on the float mechanism, and a small setscrew in the body of the oil chamber permits adjustments to be made for any temperature variation therein.

Impact Machine—This is one of the few machines of this size in the country. The tup is a simple steel casting weighing 9000 lb. and having a maximum drop of 20 ft. It is lifted by an electromagnet actuated by a 10-hp. motor. This device is used primarily for determining influence of impact on heavy railway appliances, such as draft gears, springs, knuckles and the like.

Ball-Bearing Friction Machine—This machine (Fig. 3) differs from that ordinarily designed for this purpose in that both radial and end-load friction may be determined simultaneously or separately. The various levers exerting pressure on the bearings are so proportioned that one set of weights suffice for all conditions of loading. The device consists essentially of four ball-bearing cages (two rigid and secured to the frame and two floating but constrained against rotation) fitted with bearings and riding on a special heat-treated shaft. The radial load is applied to the bottom of the two center cages, and since all bearings are equal distances apart this radial load is uniformly distributed over each bearing. The end loads are applied through the agency of suitable levers to the bearing cages in such a manner that all end thrusts are obviated except that incident to the bearings themselves. The shaft is free to move axially, and the power absorbed in overcoming friction is measured by means of a sensitive electric cradle dynamometer. The entire construction is such that only the friction of the bearings is measured by the dynamometer.

Oil-Friction Machine—In basic principle this device is similar to the "Thurston Railroad Oil Tester," but differs considerably in detail. It is capable of measuring friction loads as high as 700 lb. per sq.in. of bearing surface. The boxes surrounding the bearing are jacketed so that any uniform temperature ranging from —20 deg. F. to 400 deg. F. may be maintained. For the lower temperatures refrigerated brine is circulated through the jackets and for the higher ranges high-pressure steam is used. With this device it is not necessary to establish thermal equilibrium between bearing friction and heat dissipation from the machine as is the case with unjacketed oil-friction machines. Total pressure, speed and temperature may be varied independently.

Belt-Testing Machine—The unusual feature of this device lies in the method of speed measurement. The horsepower input and output, total tension and stretch are obtained by the usual laboratory appliances, though attention should be called to the use of an electric cradle dynamometer for measuring power input and the liberal use of ball bearings for eliminating sliding friction. The speed of the driving and the driven pulley, slips and creeps of the belt are measured photographically. Two continuous speed counters, connected by flexible shafting to the driving pulley and driven pulley respectively, are mounted together with a split-second watch under a long-focus camera. By means of a number of nitrogen-filled lamps sufficient illumination is effected to photograph the counters and watch in one twenty-fifth of a second. By comparing the photograph taken at the

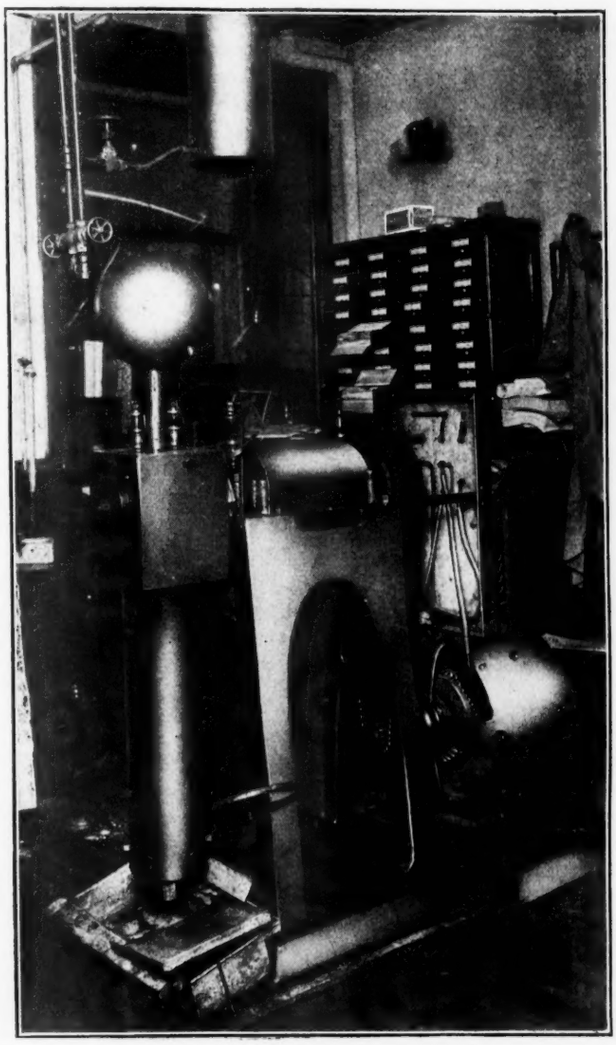


FIG. 4. OIL-FRICTION MACHINE

beginning of the run with that at the end, the total number of revolutions for each counter and the elapsed time to one-fifth of a second may be readily obtained. The counters and watch operate continuously, so that no contact mechanisms, releases or clutches are necessary when beginning or completing a run. A difference of one revolution in 30,000 per unit of time is obtained with the same degree of accuracy as one in fifty.

Boiler Control Board—In the boiler room the instrument board is of interest. It is plainly visible to the fireman when operating the boiler and contains only indicating instruments, as the recording elements are located in the engine room. Tnis board enables the firemen to note the flow of steam, flow of feed water, flue temperature, steam pressure, draft pressure drops through fuel bed, furnace and boiler and the percentage of CO_2 in the flue gases at any instant. In this respect it differs in no way from a number of test boards in general practice. The distinguishing features lie in the addition of a control valve, adjacent to the draft gages, for opening and closing the boiler damper, and a fuel counter. By turning the handle of the control valve the opening of the damper may be regulated to suit conditions, and the effect is at once visible on the draft gages. An indicating needle, in plain view of the fireman but not mounted on the board, shows the amount the damper is open. Since the coal burned is a washed nut of uniform size, the height of the coal gate and the speed of the chain are direct functions of the weight of coal burned. Thus an ordinary electric counter, actuated by the driving gear of the chain grate and calibrated for the given size of fuel and gate opening, records the weight of coal fired. Numerous tests show a maximum error of only 2 per cent. between the counter readings and the fuel as actually weighed. A special tachometer has just been constructed which will show the rate of combustion, pounds of coal per hour and per square foot of grate area per hour at any instant. This will be mounted on the board and will take the place of the present counter.

Thermal Conductometer—This is a particularly accurate instrument designed for measuring the heat flow through materials such as are generally used in cold-storage construction. Among such materials may be mentioned cork board, mineral wool, lith, rock cork, etc. The instrument may be used to measure heat flow through any material that can be prepared in flat slabs or plates.

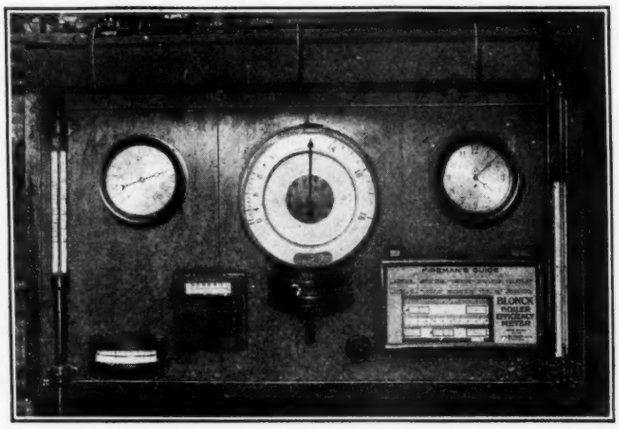


FIG. 7. BOILER-CONTROL BOARD

It consists essentially of three flat plates, each approximately 18 in. square. One is provided with a winding of resistance ribbon distributed uniformly over the surface, through which a current of electricity may be passed to heat the plate. The other plates are made hollow and are kept cool by circulating water through them.

When the instrument is in use, the hot plate is set

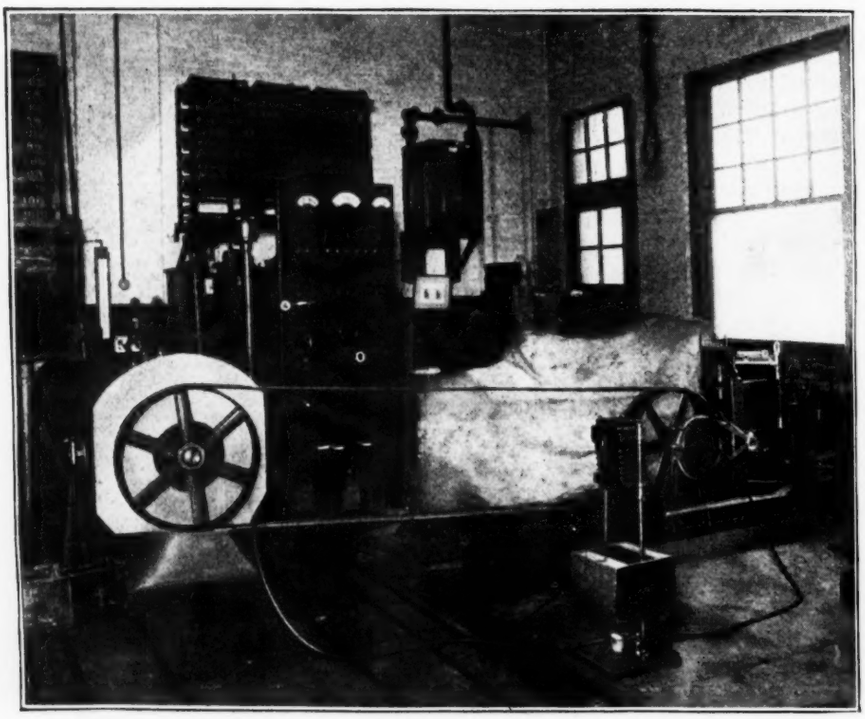


FIG. 5. BELT-TESTING MACHINE WITH PHOTOGRAPHIC SPEED MEASUREMENT DEVICES

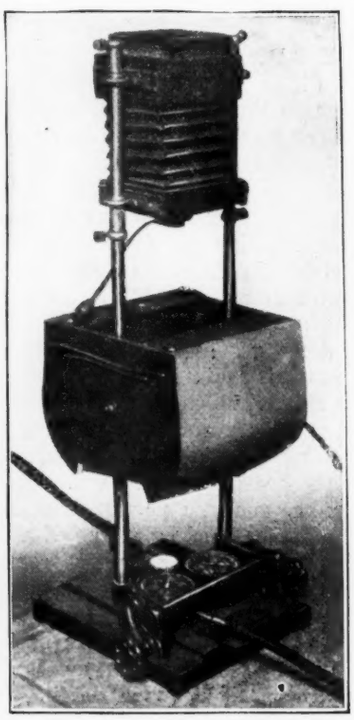


FIG. 6. SPEED-REGISTERING MECHANISM

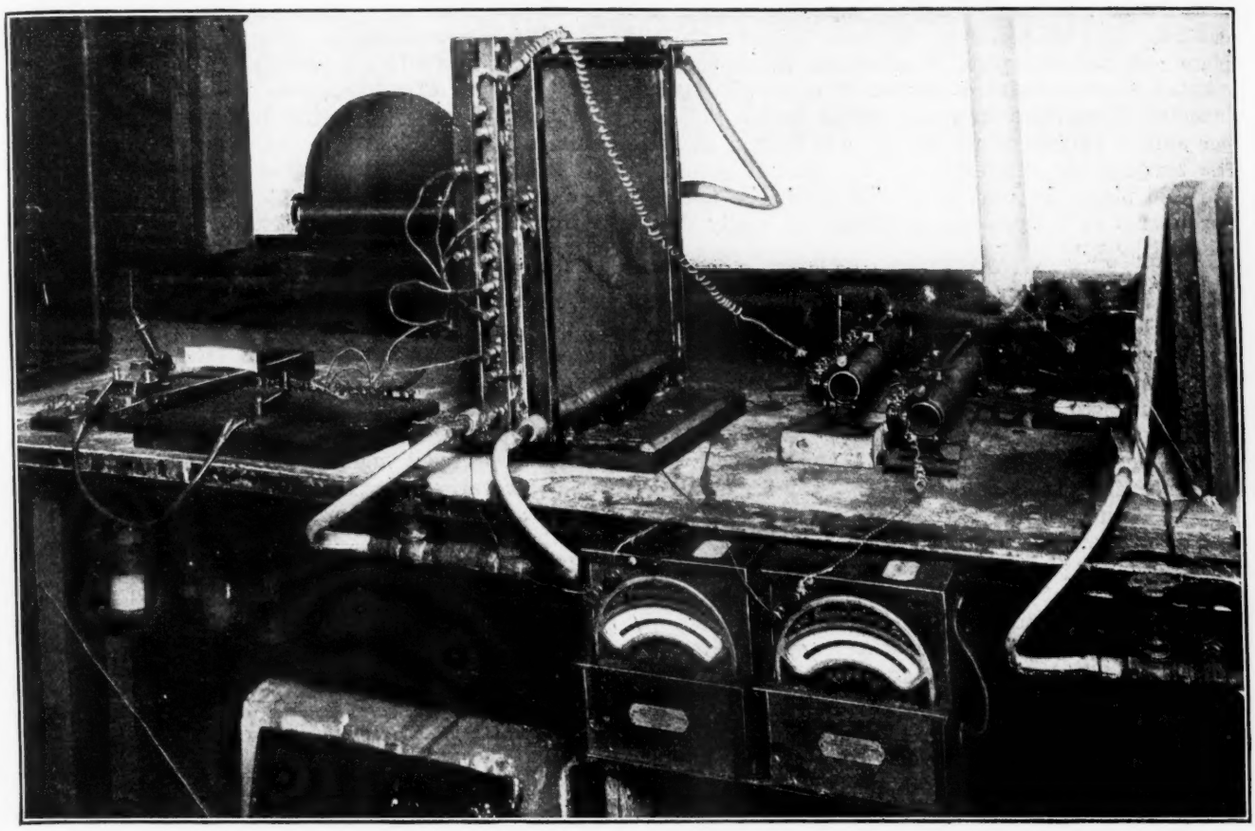


FIG. 8. THERMAL CONDUCTOMETER FOR MEASURING HEAT FLOW THROUGH CONSTRUCTION MATERIALS

up in a vertical position with a cold plate on each side. Two samples of the material to be tested are prepared, and placed one on each side of the hot plate between the latter and one of the cold plates. Thus the heat generated in the hot plate passes through the test material on both sides and into the water-cooled cold plates.

From the resistance of the winding on the hot plate

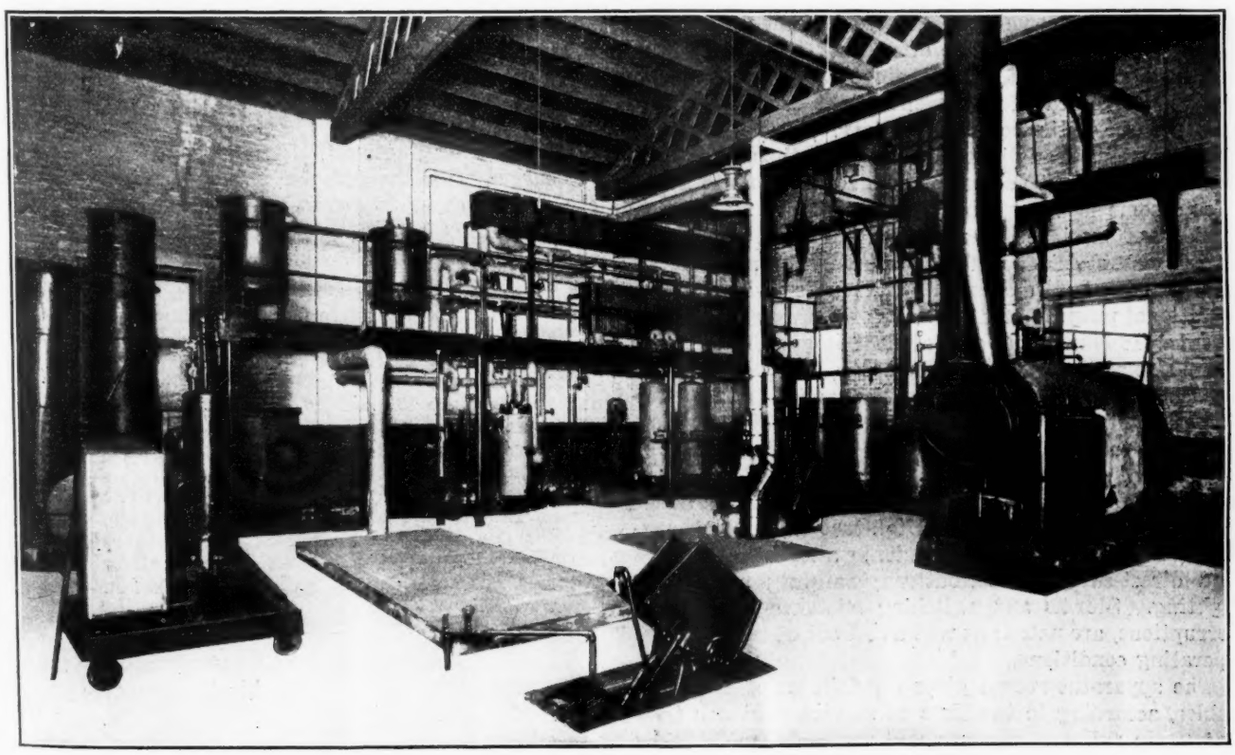


FIG. 9. COMPLETE ICE PLANT EQUIPPED TO MEASURE ALL HEAT EXCHANGES

and the current used the heat input is readily calculated. The temperature difference between the hot plate and the cold plate is measured by copper constantan thermocouples connected to a portable galvanometer. Thus since the rate at which heat is given off per unit of surface on the hot plate is known, and also the temperature difference between the hot plate and the cold plate, the heat passing through the material per degree of temperature difference is easily determined.

Ice Plant—An ice plant complete in every detail is one of the features of the laboratory equipment. It consists of a standard five-ton vertical steam-driven compressor, a double-pipe ammonia condenser, a double-pipe brine cooler, an ice tank containing 100-lb. ice cans, and a complete gravity distilling plant for the manufacturing of ice.

The apparatus is so arranged that the various heat exchanges from the "coal pile to ice ready for delivery" may be accurately determined. The quantity of ammonia circulated is obtained by means of duplicate liquid receivers placed on platform scales. Thermometer wells are placed at the various inlets and outlets of water, brine and ammonia pipes leading to and from all parts of the system. The condenser and brine cooler are insulated with six inches of granulated cork within a specially constructed tight box.

The engine is supplied with steam from a 25-hp. semi-portable internally fired boiler, which is fully equipped for standard A. S. M. E. tests. The engine can be run condensing if desired or the steam may be condensed in the atmospheric steam condenser of the distilling system.

The System Log-Sheet Index

BY FRANK GILLOOLY

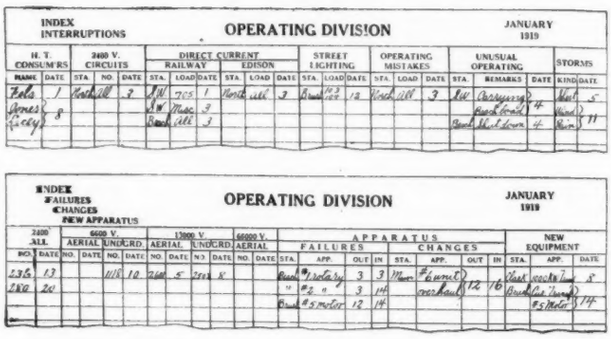
The details of last month's interruption or of last year's big shutdown are likely to be fresher in mind than the exact date of the occurrence. If some special method of filing such happenings is not pursued, to locate the record of any event might entail a day-by-day perusal of the voluminous diary. In one large system where the load dispatcher's log was the official operating record, that volume became so bulky as to necessitate some means of making its contents more accessible; and an index was devised for notating according to classification, all major operating events.

The index is filed according to months and serves the additional purpose of affording a monthly summary of events. It is made up on loose-leaf ledger sheets of the same size as the load dispatcher's log, though ultimately filed in a volume separate from that report, and the entries are made at the end of each day. Two sheets are used—a service record, shown in the upper part of the figure, and an apparatus record, in the lower part of the figure. All service interruptions are listed under the class of distribution: High-tension, or primary-voltage consumers; low-tension, alternating-current and direct-current distributions; railway; and street lighting. Storms and switching mistakes causing interruptions, are noted; as well as all out of the ordinary operating conditions.

The apparatus record gives the failures of lines and cables, according to the class of service on which they are used; failures, changes and removals on all other station apparatus, according to stations; and a record of all new equipment. Only one entry is made for each event; it gives the date, station and identity of the apparatus or load affected—excepting that a failure causing five kinds of interruptions would be considered as constituting one and causing five other events, and six entries would be made on the index. Cables are not considered as station apparatus and are listed by number only.

On the interruption report the word "all" has the meaning of "total" or "complete" interruption to the class of service denoted by the heading of the column in which it appears. If the load of one distribution circuit is lost, the number of that circuit is given; if several circuits are interrupted, the word "miscellaneous" appears; if all the load is lost, the word "all" is written.

In the two years during which it has been in use, the index has proved a valuable time saver for locating material for various reports and studies, as well as providing a complete summary of operating conditions.


INDEX INTERRUPTIONS — OPERATING DIVISION — JANUARY 1919

H. T. CONSUMERS		2400 V. CIRCUITS			DIRECT CURRENT RAILWAY			DIRECT CURRENT EDISON			STREET LIGHTING			OPERATING MISTAKES			UNUSUAL OPERATING		STORMS	
NAME	DATE	STA.	NO.	DATE	STA.	LOAD	DATE	STA.	LOAD	DATE	STA.	LOAD	DATE	STA.	LOAD	DATE	STA.	REMARKS	DATE	KIND	DATE
Folz	1	North Hill	3		S.W.	705	1	North Hill	3		Bush	103	12	North Hill	3		Rel	Carrying	4	Wind	5
Jones	8				S.W.	Misc	3											Back Load			
Greys					Bush	Hill	3										Bush	Shut down	4	Wind	11

INDEX FAILURES CHANGES NEW APPARATUS — OPERATING DIVISION — JANUARY 1919

2400 ALL		6600 V. AERIAL		6600 V. UNDGRD.		13000 V. AERIAL		13000 V. UNDGRD.		66000 V. AERIAL		APPARATUS FAILURES			APPARATUS CHANGES				NEW EQUIPMENT		
NO.	DATE	NO.	DATE	NO.	DATE	NO.	DATE	NO.	DATE	NO.	DATE	STA.	APP.	OUT	IN	STA.	APP.	OUT	IN	STA.	APP.	DATE
236	13			116	10	208	5	208	8			Bush	#1 Rotary	3	3	Main	#1 Induct			Shut	switch	8
240	20											"	#2 "	3	14			12	16	Bush	Arr. Board	
												Bush	#5 motor	12	14						#5 Motor	17

SERVICE-RECORD AND APPARATUS-RECORD SHEETS

With modifications to suit local conditions the method should prove of equal value on any system, large or small, and could be made a yearly instead of a monthly record. The loose-leaf ledger has the advantage over the card-index file of being more agreeable to handle, the complete index being contained in one volume.

Engineer's Assumption of Risk

Where the engineer of a stationary engine and boiler is charged with the duty of inspecting and repairing the equipment or to report need for repairs, his employer will not be liable for his injury resulting from an explosion of the boiler due to its defective condition, the engineer having given no notice of needed repairs.

The reason for the foregoing rule relieving the master of liability to the injured servant whose duty it is to inspect and report defects is apparent. Negligence is the violation of some duty which the party charged with it is under obligations to perform, and necessarily, if there is no duty to do the thing complained of, there can be no negligence in failing to do it. The duty of the master to repair, in cases like this, arises only when he is notified by his servant of the necessity of such repair, and if the servant fails to give such notice and continues to work, he assumes the risk, and if injured he cannot look to the master. (Kentucky Court of Appeals, Drake's Administrator vs. Mountain Central Railroad Co., 208 Southwestern Reporter, 765.)

A Dutch engineer has evolved a new method of freeing boiler feed water of oil. He subjects the water to the action of 110-volt continuous current, which causes the oil particles to combine into larger masses, after which they are removed by pressure filters.

Care of Heating and Ventilating Equipment—IX

By HAROLD L. ALT

Several vapor systems are taken up in this article and their characteristics are explained, together with information regarding some of the special apparatus used with each.

THE ordinary term "vapor system" may be interpreted as any system of steam heating that operates at or near to atmospheric pressure and in which the condensation is not returned to the boiler by a mechanical pump or other positive displacement device. Such systems are designated by many different terms and in this variety of names lies the cause of a large amount of the confusion that exists in regard to them. "Vacuum-vapor," "atmospheric," "modulated," "vapor-vacuum" and "thermo-grade" are all terms applied to the various types of such systems. There are numerous patented devices, made and developed by the various vapor heating companies, which have contributed much toward popularizing and making commercially successful the vapor heating idea.

Primarily, vapor heating plants were developed for small-residence work, but their success has gradually

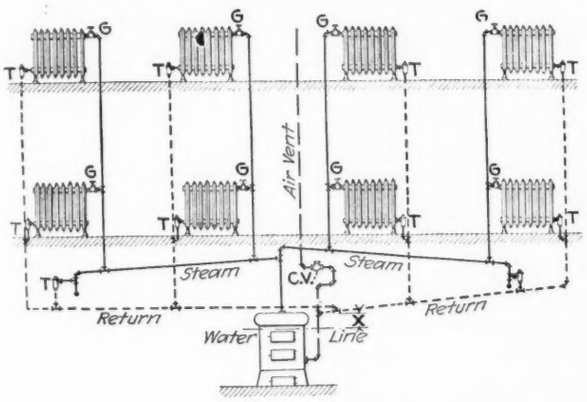


FIG. 1. PIPING OF VAPOR SYSTEM

given them an increased field so that now they are used in the largest buildings. This justifies their discussion at considerable length.

Vapor systems may be classified as those employing traps on the radiator returns and those employing open returns. These two systems are subdivided into those returning their condensation to the boiler by gravity and those which employ a special trap of some sort to return the condensation to the boiler against the boiler pressure. The fundamental idea back of all vapor systems is that it takes a less intense fire to evaporate water at or below atmospheric pressure than it does at higher pressures. Therefore a circulation of vapor can be obtained with less fire than would be possible were it necessary to generate steam under pressure. In some systems a pressure slightly above the atmosphere is first generated in order to blow out the air and then the vapor in the system is allowed to condense and form a partial vacuum. Other systems use a slight pressure (a few ounces only) at all times, and still others endeavor to maintain a partial vacuum at all times by various expedients.

Any hot-water radiator with a graduated valve, any steam boiler with sensitive control, any two-pipe gravity system of piping with a dry return open to the atmosphere in conjunction with a thermostatic trap for each radiator may be easily converted into a true "vapor" system, as will be seen in Fig. 1. Other special

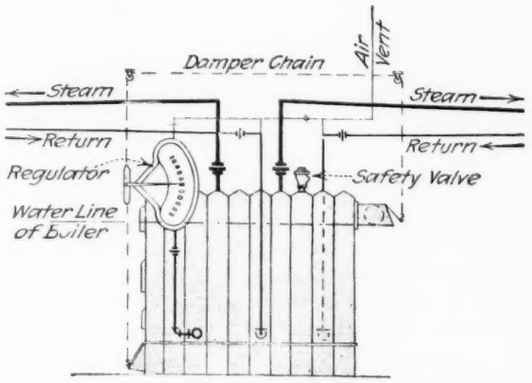


FIG. 2. REGULATOR FOR BOILER CONTROL

devices may be added and the piping may be modified until the original layout is hardly recognizable. Steam is generated in the boiler and passes up into the steam main supplying the radiators, just as in a two-pipe gravity system, and enters the radiators through the top inlet (where usually a graduated valve is placed) and fills a portion of the radiator, as determined by the graduation of the inlet valve *G*. In entering the radiator the steam pushes the air ahead, forcing it out through the return connection at the opposite end, and in this respect the "vapor system" resembles the "vacuum system." The steam entering only at the rate permitted by the valve condenses within the radiator, the condensation passing down and out of the return connection along with the air. If the valve is opened full so that the radiator is filled with steam,

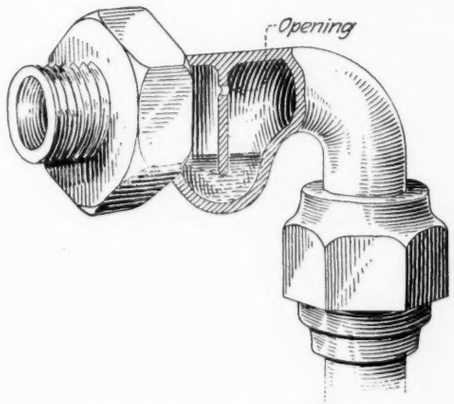


FIG. 3. RADIATOR RETURN TRAPPED ELBOW

the trap *T* on the return line becomes hot and closes off until sufficiently cooled condensation has collected and reduced in temperature to such a degree that the trap opens and relieves the water. The radiator traps used on the returns of a "vapor" system are identical with those used on "vacuum" systems and serve the same purpose; namely, they prevent the entrance of

steam into the return line and thereby prevent the accumulation of pressure in that line. The air and water then pass down the return lines to the main return and along this main to the point where it has a vent taken off; here the air and water separate, the air going out at the vent and the water flowing into the boiler.

If it is desired, this system as shown can be operated at a pressure of one or two pounds provided the distance *X* (between the water level in the boiler and the low point in the return header) is made about three feet for every pound of steam carried. Unless such a distance is maintained the water in the boiler having the steam pressure exerted on its surface, while the water in the return has only atmospheric pressure, will cause the boiler water to back up in the returns until a state of equilibrium is reached, and if the return main is too low it will be flooded and airbind the system. Should it be desired to operate the system, at times, below atmospheric pressure, an "impulse" check valve (*C. V.*) installed in the vent line will effectually prevent the air rushing back into the system when the fire goes down, and the resulting vacuum will produce a circulation of vapor throughout the system for some time.

Should it be desired to dispense with the radiator traps and use an open return, additional "condenser" surface amounting to anywhere from 10 to 25 per cent must be installed on each radiator. The purpose of such additional surface is to care for any slight excess vapor that may be delivered to the radiator by the graduated valve when turned on full. It has been found

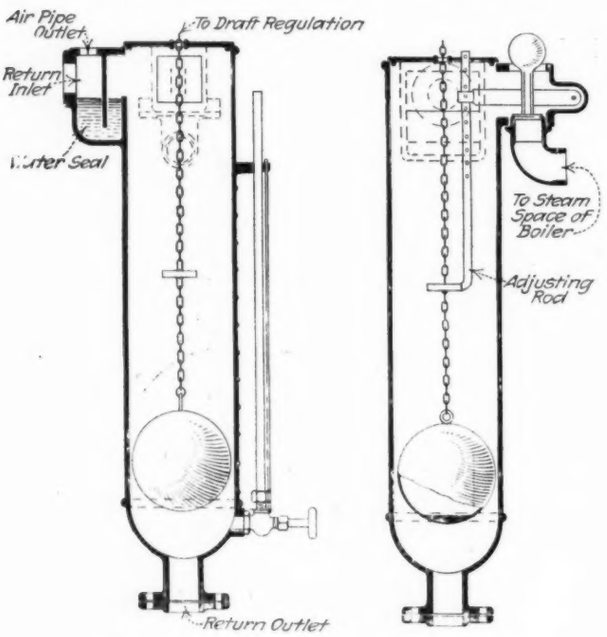


FIG. 4. RECEIVER FOR AIR VENTING

impossible to set the graduated valves to control the vapor to any limits smaller than this, and it has proved impractical to vary the valves for every small change in radiator surface. On the other hand, if the same valve is used on a radiator of 40 sq.ft. as on one of 50 sq.ft., then the 40-sq.ft. unit must have 25 per cent. additional surface to condense all the steam the valve will supply when turned on full. Most of the patented systems of vapor heating employ special graduated valves and return traps (of the types already described under vacuum systems) and have special devices for air venting, boiler regulation and for returning the water of condensation against the boiler pressure when the system is operating under pressure.

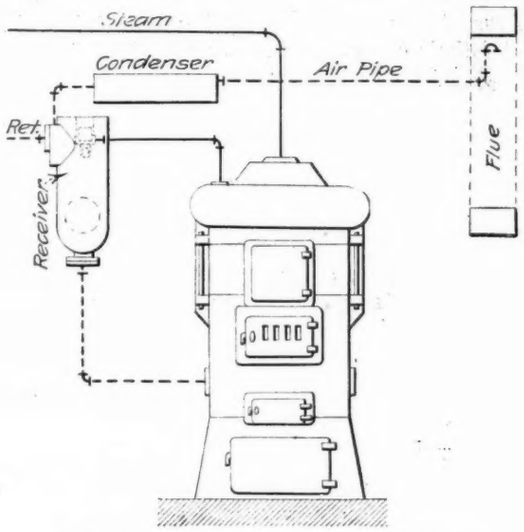


FIG. 5. PIPING OF VAPOR CONDENSER

In the system known as the "Adsco" an open return is used together with piping somewhat along the lines of that shown in Fig. 1 excepting that a special means of damper regulation is used. A graduated valve is arranged to give a different quantity of steam for each 5 sq.ft. change in the radiation and opens and closes with a three-quarter turn of the handle. On the return end no special trap or fitting is used, simply a union elbow, and in order to prevent steam blowing out into the return line the inlet valve is designed to supply only sufficient vapor to heat 80 per cent. of the radiator. This means that the radiator surface is some 20 per cent. greater than would be required if all the surface was active. The most distinctive feature of this system, however, is the boiler control, which is by means of a special regulator connected as shown in Fig. 2. The regulator itself consists of a cast-iron chamber, with a dial and pointer on the front as shown, inside of which there is a float which rises and falls as the water from the boiler backs up in the returns. This controller is connected to the damper chains and can be made to regulate the draft and fire so as to produce any pressure desired, determined by the setting of the regulator.

Another vapor system, called the "Broomell" employs the so-called "Quintuple" valve and is an open-return system. It involves, however, the use of a special tapped elbow, Fig. 3, on the radiator return with a water seal of sufficient depth to prevent the vapor, at the very slight pressure maintained, from passing through, while a little hole in the partition permits a small but constant venting of air from the radiator into the return line. This answers in a very simple manner the purpose of a trap by the use of the water seal. In this system, however, the most distinctive feature is the receiver and method of air venting. The return line, carrying air and water, instead of being connected directly to the air vent and boiler, is run to a receiver, two sectional views of which are shown in Fig. 4. This receiver consists of a hollow cylinder inside of which is a float connected to damper chains, the operation be-

ing similar to the regulator already described; but owing to its peculiar construction, it does more than control the dampers by the float rising as the water backs up from the boiler into the receiver. At the opening marked "Return Inlet" there is a water seal, but there is no hole in the partition, as there is in the water seal at the radiators, for the air to pass through; instead, it finds its way out through the opening marked "Air-Pipe Outlet" to a condenser, usually hung on the basement ceiling, thence to the chimney or stack, as shown in Fig. 5. Any vapor that may be mixed with the escaping air is condensed in this condenser. The outlet of the condenser is run to a chimney flue and opened inside of the flue, so that whatever chimney draft there may be will assist in drawing out the air.

The receiver performs another function also. On the side of the receiver and set at 90 deg. with the inlet is an opening which is connected to the steam space of the boiler, but the vapor is prevented from flowing through by a weighted valve. If any unusual pressure is generated in the boiler, the float rises far enough to strike the lower end of the adjusting rod opening the valve, which may properly be considered a safety valve, thereby relieving the boiler pressure by allowing the excess vapor to escape. The water in the receiver (owing to the reduced pressure) then sinks down and the valve closes ready to repeat the cycle. The return water flowing into the receiver finds its way back to the boiler through the bottom opening marked "return outlet." Thus it can be seen that this receiver is really a combined air relief, damper regulator and safety valve.

The Hutchinson is also an open-return system employing a modulating valve on the radiator inlet and a

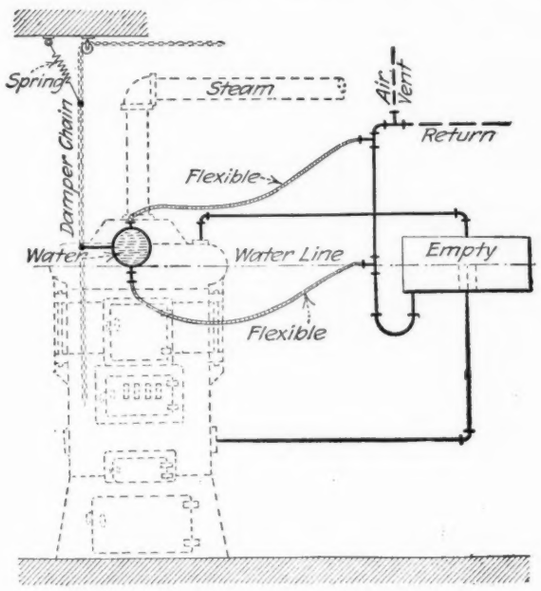


FIG. 6. DRAFT-CONTROL CONNECTIONS

simple union elbow on the outlet. The radiator surface is about 20 per cent. greater than the modulated valve is expected to supply to prevent vapor getting into the returns, and the air vent is taken off the top of the return somewhat similar to the method illustrated in Fig. 1, but between this vent and the boiler there is a unique device which controls the draft by means of a hollow sphere mounted at the end of a flexible connection pipe. When the vapor pressure is low, the hollow bulb is partly or entirely empty and is pulled into the upper position by the spring attached to the draft chain. As soon as the vapor pressure is sufficient, it forces the water in the receiver back into the water seal on the return until it reaches the branch pipe running horizontally out to the bulb. The water enters the bulb, increasing the weight, and causing it to overcome the spring tension, thus operating the draft-regulating chains. The various connections are shown diagrammatically in Fig. 6. The small pipe connected from the top of the bulb to the return main is a balance pipe which allows the free flow of water into and out of the bulb. The receiver also has a balance pipe, so that the water in the boiler connection really does not rise up into the receiver, but instead, the boiler pressure is applied on top of the water in the receiver, and forces the receiver water back through the water seal so that it is the receiver and seal water which really floods the bulb. If the bottom door is left open, however, and the movement of the bulb fails to check the increase in pressure, a more or less dangerous condition develops. The vapor pressure continues to increase in the receiver, blows out through the water seal and back into the return line, from which it is relieved by the air vent to the outer air.

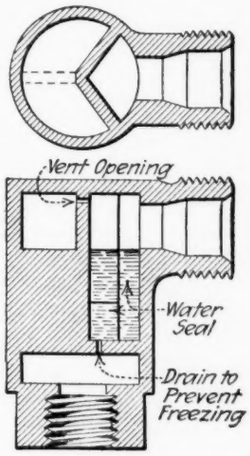


FIG. 7. SPECIAL RETURN FITTING

The Mouatt vapor heating system is another patented arrangement with an open return. The radiation is increased like the other open-return systems and a graduating valve is used on the radiator supply. On the radiator return connection a special return fitting is used, its construction being shown in cross-section in Fig. 7. The condensation comes back in the return main, which is air-vented where the line drops down to enter the boiler, and a check valve is placed close to the boiler tapping. The air vent itself is terminated in a chimney flue so that the chimney draft will help draw the air out of the system. The return in this system is in no way connected to the damper regulator.

The regulator deserves a brief description, since on its operation depends the success of the whole system. The regulator, as shown in Fig. 8, consists of a cylindrical tank *A*, mounted on a lever *B* which is counterbalanced by a weight on the other end. When the tank fills with water it outweighs the counterweight and falls, operating the draft chains. This lever is supported on a pivot pin on a small receiver, which is filled with water through a filling plug. A vapor pressure pipe is connected from the top of this receiver to the steam space of the boiler, and an overflow pipe is also provided so that any excess water will flow back to the boiler. Upon the vapor pressure increasing, the water in the receiver is forced out through the bottom opening into the flexible connection running to the lever arm and finds its way into the tank *A*, causing it to close the draft as described. When the pressure has been reduced a few ounces, the water runs back into the receiver and the tank is lifted by the counterweight, again opening the drafts.

The Moline system uses an open return, but incorporates a key-operated valve thereon so as to permit the cutting off of any radiator by the simple closing of the graduated valve used on the radiator supply and the lock shield valve on the return. In other respects the system does not follow the lines of those previously described. The return line has a seal, and a positive vacuum is maintained in it by a steam ejector, so that

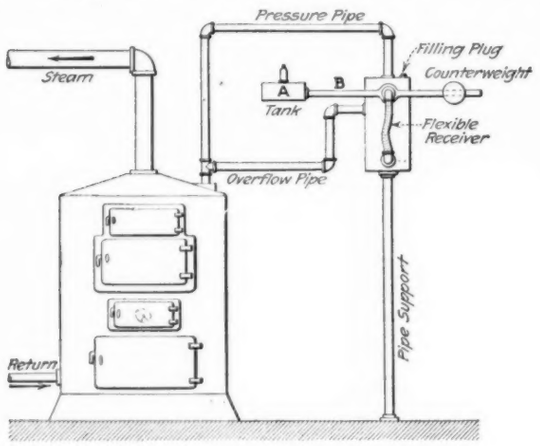


FIG. 8. REGULATOR AND PIPING

expelling air from the system is promptly accomplished; and after the air is once expelled, its reëntrance is prevented, so that the system continues to operate under a vacuum of greater or lesser degree until inleakage destroys the vacuum.

The details are as follows: The return line is carried back to a point near the boiler as usual and is cross-connected with the return, or bleeder, end of the steam main, which is also brought back as in a one-pipe circuit system; this cross-connection is made as illustrated in Fig. 9, with the ejector tee fitting arranged so that the blowing of steam or air through the fitting will produce a suction on the return line, thus drawing the air and vapor out of the return and accelerating the flow through the radiators. As the steam opening in the ejector fitting is small, only a small amount of steam is included in the mixture of air and vapor discharged by the ejector; this discharge passes into a small coil of pipe which serves as a condenser, where the vapor is reduced to water and finds its way back to the boiler through a drip at the end of the condenser. The air itself is relieved through a large air valve at the end of the condenser loop, with which is combined a vacuum valve which prevents the reëntrance of air at this point. The damper regulator is of sensitive type, but is in no way connected with the piping system. This regulator is connected directly to the boiler in much the same manner as the ordinary boiler regulator, simply controlling the dampers according to the pressure to a fine degree.

When this system is started, a slight steam pressure is necessary in order to blow the air out of the steam main through the ejector tee. This action at once starts the suction on the radiator return line so that the steam rapidly fills the radiators to the degree permitted by the position of the supply valve and progresses down the return, driving the air ahead of it and finally reaching the ejector tee. The vapor or steam following the air soon fills the condenser, and being much more than the condenser can handle, the steam and vapor pass through this coil of pipe and strike the air trap, which closes against any further flow. At this time the system has been entirely rid of air, and if the fire is allowed to go down the condensation of the steam in the system at once tends to produce a high degree of vacuum and the lower the fire the more nearly perfect this vacuum becomes. Because there is practically no air in the system, the vapor fills the entire system and keeps all the radiators hot. After considerable air has leaked in through various small openings and the vacuum is reduced, it is then necessary to generate a little steam pressure for the purpose of again blowing out the system. The periods between blowing out, however, are usually more than 24 hours, so that starting the fire each morning (or at the most morning and evening) is sufficient to maintain a good degree of vacuum at all times.

With the systems using the closed return may be classed the Webster modulation system. This uses graduating valves on the supply and thermostatic traps or valves on the radiator returns. The chief advantages of the closed or trapped return are the more or less positive obstruction to vapor getting into the return line and the fact that it is unnecessary to increase the radiator surface over that actually required to do the heating, as in the case of the open-vent systems. The chief disadvantages to the employment of traps on radiator returns are increased cost and the danger of some foreign particle lodging on the seat, interfering with the operation of the valve. In the Webster system the return line is brought back and connected to the boiler through a check valve, but before dropping the return down below the level of the water line in the boiler, an automatic air trap is connected in. The function of this trap is to relieve the air from the system, and a check valve on the air-vent pipe prevents its reentrance, so that the only way air may enter the system is through normal leakage.

The Marsh modulation vapor system is quite similar to the Webster as far as piping is concerned. The

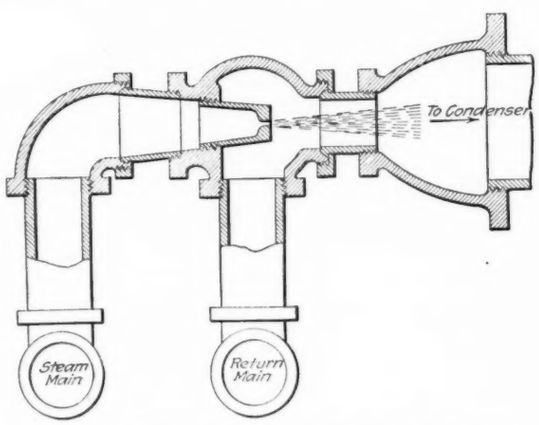


FIG. 9. EJECTOR FOR PRODUCING SUCTION

radiators are controlled by a graduated valve on the supply and a thermostatic trap on the return of a slightly different design. Where the return drops below the boiler water line, a rapid air vent or eliminator is used. This is really only an automatic air valve of large size operated by a thermostatic disk and an inverted cylinder float.

In so far as the operation of vapor systems is concerned, it has been the endeavor of all manufacturers to

make them and the devices which go with them as nearly automatic as possible, so that the chief duty of the operating engineer is to keep his fires up and to know when his equipment is doing the work it should do. The most serious difficulty is teaching of the occupants of the various rooms to manipulate the radiator valve rather than to open the windows. For this reason most graduated valves are of the quick-opening type, giving all settings from closed to full open in less than one full turn of the spindle in order that it will be found easier to close the valve than it is to raise the window.

The foregoing covers in a general way the more common types of vapor heating systems, although there are many others more or less popular to which the same principles apply with slight modifications, so that further discussion is hardly necessary.

Heating Caused by Cracked Crankpin of Diesel Engine

By D. L. Fagnan

An early type of vertical three-cylinder Diesel engine had been operating for some years pretty well loaded, but giving the finest kind of service. It was a marvel to every mechanic who watched it work. Then suddenly it developed a hot crankpin on No. 2 cylinder. The engine was equipped with bronze bearings throughout, the main bearing being spotted with babbitt metal and plain bronze being used on the crankpin. The engineer had scraped and cleaned the brasses three times and was ready to swear that there was no cause for further heating. In fact, he had expended all his mechanical knowledge of how to fit a bearing of this kind, but apparently to no purpose. The crankpin bearing heated again and again and all the oil in the world could not keep it cool.

In despair, a telegram was sent to our company, and although we had not built the engine originally, I was sent to set things right. The engineer was a fine mechanic, and when I first looked at the engine I realized that I was up against the real thing.

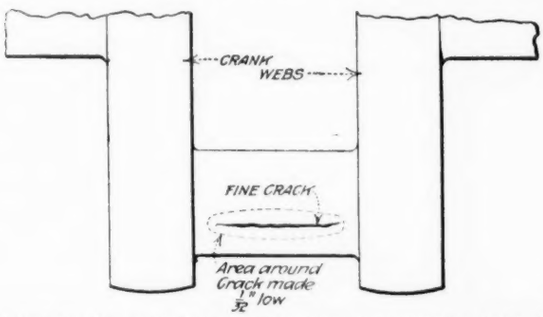
I lit my old pipe and examined the engine thoroughly, observing the cam setting on the cylinder whose piston was nearest dead-center position, and making a mental note that it looked about correct. I next examined the interior of the crankcase with a portable lamp. The oil seemed to be new and of good body and the interior of the case clean and orderly.

Next I calipered the crankpin in at least a hundred places and could detect very little variation from roundness—certainly not enough to bother about. The engineer watched my operations and volunteered the information that after the second scraping he had spent fourteen hours filing and truing up the crankpin, finally polishing it highly, and still the heating persisted. When he impatiently asked what I thought of that bearing, I answered that I had only begun to do some real thinking and that I would find the cause of the heating or else admit that Diesel-engine tricks were too much for me.

A magnifying glass or reading glass about three inches in diameter is always a part of my kit, being used principally to locate the railroad stations given in small print on Western maps. I used this glass on the crankpin, also a mirror to reflect light into the corners and angles, but I could detect no flaws or anything wrong. However, common sense told me that there must be something radically wrong with either the pin or the bearing, and possibly with both.

I had heard that after repeated heating a bronze bearing will lose some of its antifriction properties. So I reëxamined the brasses, testing the bearing surfaces in many spots with my small, sharp scraper to see whether any very hard spots existed. I tried each half of the bearing in the rod end to see whether there was any binding and found that each pushed home fairly easily, so that here at least was no chance for trouble.

Finally, I poured kerosene on the crankpin and rubbed some prussian blue on it, working this over the pin thoroughly by using a half shell. It showed a fine bearing and plenty of clearance where required. I then lighted a gasoline torch and approached the crank case, protecting my face and body in case there should be explosive gases present. Finding none, I gradually worked the torch up to the crankpin, poured more kerosene on the pin and heated this up with the torch



LOCATION OF THE CRACK IN THE CRANKPIN AND THE AREA THAT WAS FILED DOWN

until the pin could scarcely be touched with my bare hands. With a rag having prussian blue on it I rubbed the pin hard all over and then with clean cloths wiped it off. If there are any cracks or flaws in a piece of metal, this treatment will show them up.

To my great joy, my glass showed dirty oil and prussian blue oozing out from a fine crack lengthwise of the pin, as shown in the illustration. Wiping it off twice did not blot it out. The engineer was jubilant, although he admitted he could hardly believe that a little crack like that could cause such a lot of trouble. The crack must have been of some depth, for after five wipings it still continued to ooze oil slowly. As it was lengthwise of the pin, we concluded that it did not weaken the pin greatly.

It was our opinion that the sharp edges of the crack working on the brasses when the engine was running caused heating by continually scraping off the lubricant and also by making a powder out of the brasses. So we decided to file the pin down until it was about $\frac{1}{32}$ in. low in the neighborhood of the crack, as indicated by the area outlined in the illustration, so that the pin surface at the crack could not touch the brasses again. We then assembled the engine and started it carefully. We ran it for four hours, feeling that crankpin bearing often, but not a sign of heating developed after the initial heating that always manifests itself when a new bearing is started.

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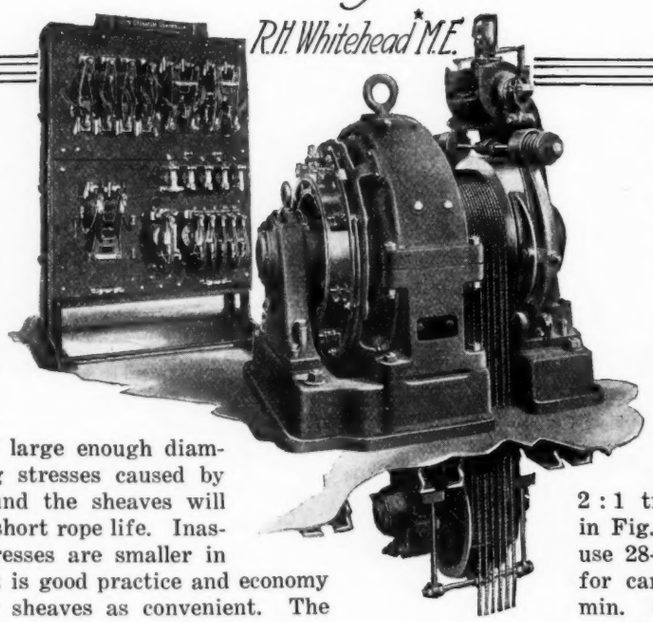
Geared and Gearless Traction Elevator Machines

By R. H. Whitehead* M.E.



IN THE traction type of elevator machine the car-hoisting ropes travel at the peripheral speed of the driving sheave, and the friction between the ropes and sheaves must give sufficient traction to care for all conditions of car loading without slippage. The driving sheaves used must be of large enough diameter so that the bending stresses caused by the ropes traveling around the sheaves will not be sufficient to cause short rope life. Inasmuch as the bending stresses are smaller in the larger size sheaves, it is good practice and economy to use as large-diameter sheaves as convenient. The maximum size of the driving sheave is limited by two factors: First, it must not exceed the span distance between car and counterweight centers (see Fig. 3); secondly, by the allowable speed of the driving sheave, since an increase in diameter with the same speed of rotation results in an increased car speed.

In the worm-geared type of traction machine as shown in Fig. 1, a high-speed motor is used, and the desired speed of the car is obtained by using the proper gear reduction. The motor speeds for this type of installation vary from 600 to 1200 r.p.m., depending on the motor's horsepower, the larger horsepowers being possible only at the slower speeds. In worm-geared-traction machines manufacturers endeavor to use as high-speed motors as possible compatible with good engineering practice. It is well known that for a given horsepower rating a slow-speed motor is larger than a high-speed one, which results in higher costs. The torque, or pull, of a high-speed motor is less than that of a slow-speed machine of the same horsepower. Therefore the size of brake, which is designed to hold full-load motor torque, the size of the wormwheel shaft, and in fact the entire machine is lighter when using a high-speed motor as compared with a slow-speed machine of like horsepower.

The size of the driving sheave on a worm-geared machine depends on the gear ratios available for the high-speed motors used with this type of machine, and the speed of the motors depends on the duty. It has been found that the diameter of sheaves for good rope service depends not only on the size and kind of rope, but also on the rope speed. It is general practice to use $\frac{5}{8}$-in. extra-flexible steel cables on 36-in. sheaves for traction machines with 1:1 roping for speeds of 600 ft. per min., roped as in Fig. 3. On 2:1 traction machines, roped as in Fig. 4, it is general practice to use 28-in. sheaves and $\frac{1}{2}$-in. cables for car speeds up to 450 ft. per min. On slower speed traction machines it is permissible to reduce the sheave diameter. In a number of installations, on the higher speeds, smaller-sized sheaves are used, but this results in shorter rope life for like operating conditions than with sheaves of standard sizes. Short rope life may also result from poor quality of ropes due to manufacturing conditions or to neglect in keeping all the hoisting ropes under equal tension. There is, however, a difference of opinion among engineers as to the proper diameter of sheave to use for various sizes of ropes under different conditions.

Summing up the preceding, in a worm-gear-traction installation the manufacturers of elevator machines use high-speed motors to keep down the cost and use sheaves as large as the worm-gearing reduction will permit without exceeding the span distance of car center to counterweight center. This limits the speed of the worm-gear-traction machine to 450 ft. per min. for loads up to 2500 lb., as it is possible to get only certain minimum worm-gear reductions. For instance on this duty the motor's speed would be 600 r.p.m. With 1:1 traction $\frac{5}{8}$-in. ropes would be used on minimum-sized sheaves, of 30-in. diameter, for good rope service at this speed. The driving sheave would rotate at $450 \div \frac{30 \times 3.1416}{12} = 57.4$ r.p.m. With a 600-r.p.m. motor the gearing reduction would be about 10 to 1. This is about the limit of worm-gear reduction for elevator machines, although a 12-thread worm has been

*Engineer with Geo. W. Goethals & Co., Inc.

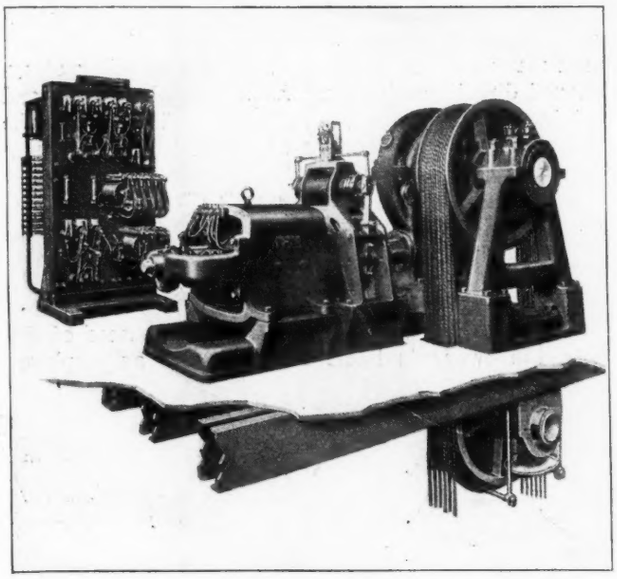


FIG. 1. WORM-GEAR TYPE TRACTION-ELEVATOR MACHINE

used with a 108-tooth gear wheel giving a speed reduction of 9:1. It is obvious that it is not practical to build worm-geared-traction machines for speeds in excess of 450 r.p.m., and this speed presents difficulties in manufacturing on account of the large number of threads on the worm. The worm-geared-traction machine is most suitable for speeds up to 350 ft. per min., and where a speed of 450 ft. per min. is desired either herringbone-gear reduction machines or the 2:1 gearless-traction machine is preferable.

Elimination of the worm and gear results in smoother operation and quicker acceleration. The gearless-traction machine shown in the headpiece and in Fig. 2 uses a driving sheave and brake wheel attached directly to the motor shaft. Inasmuch as the dimensions of a motor for a given horsepower increase as the speed decreases, gearless-traction elevator motors are very large for their horsepower rating. A standard 60-r.p.m. motor rated at 38 hp. is several times larger and more costly than the same size motor of 600 r.p.m. used on the worm-geared-traction machine. The brakes are also larger and more costly since the torque of a 60-r.p.m. motor is ten times as much as the torque of a 600-r.p.m. one of like horsepower. In general the gearless-traction elevator motor used on the 2:1 installations, as shown in Fig. 2, has about twice the speed of the motor used on the 1:1 installation, shown in the headpiece, and is consequently much lighter in weight.

As the driving sheave rotates at the motor's speed, on the gearless-traction machine, this machine is in general practical for installations requiring high car speeds, from 450 to 700 r.p.m. This range of speed is in general required only in very tall buildings, with the exception that an installation of this character is sometimes used in medium-height buildings, such as department stores, to obtain the advantages of the smooth operation and quick accelerating characteristics of this type of machine.

For 2:1 installations roped as in Fig. 4, ½-in. ropes are generally used on 28-in. sheaves. For a 450-ft.-per-min. car speed the driving sheave and motor must rotate at $450 \div \frac{28 \times 3.1416}{12 \times 2} = 122$ r.p.m. Slower speeds than 450 ft. per min. are sometimes obtained by the use of smaller sheaves than 28-in. but experience has shown that this will result in short rope life. In the 2:1 type of installation the ropes travel at twice the car speed and around two more sheaves, one on the counterweight and one on the car, than in the 1:1 type. The rope life in this type of installation is liable to comparatively short life, caused by the ropes traveling around so many sheaves at high speed. This disadvantage may be outweighed where heavy traffic from floor to floor requires quick acceleration for rapid traveling.

The 1:1 gearless-traction machine is used only with high car speeds and high rises, from 300 ft. up. The usual installation has a 36-in. sheave and uses ⅝-in. ropes. A 36-in. sheave driven by a 60-r.p.m. motor gives a car speed of 570 ft. per min. Elevators of this type give good rope service and are built for speeds up to 700 ft. per min., which is the maximum allowed by law in New York City. For a 2500-lb. carload at 600 ft. per min. the motor has a rating of 38 horsepower.

Certain installations require the application of a gearless-traction motor of the very slow-speed type to a comparatively slow-speed installation, as the amount of power that can be transmitted by a worm and gear is limited to approximately 50 hp. There is no limit to the amount of power that can be applied to a gearless-traction elevator, except the space requirements for the machine. In the New York subways at certain stations lifts are provided from the train platforms to the street levels capable of handling 11,000 lb. at 350 ft. per min., using gearless-traction elevators roped 2:1.

In Fig. 5 is shown the roping of a V-groove traction-elevator machine. This type of drive is now under test with gearless-traction machines to determine the relative life of ropes as compared to the standard type using a secondary sheave.

In the case of the standard type the ropes make two half-turns around the driving sheave and one half-turn around the secondary sheave, as compared to one half-turn on the driving sheave of the V-groove type. The pinching effect of the V-grooves on the ropes may,

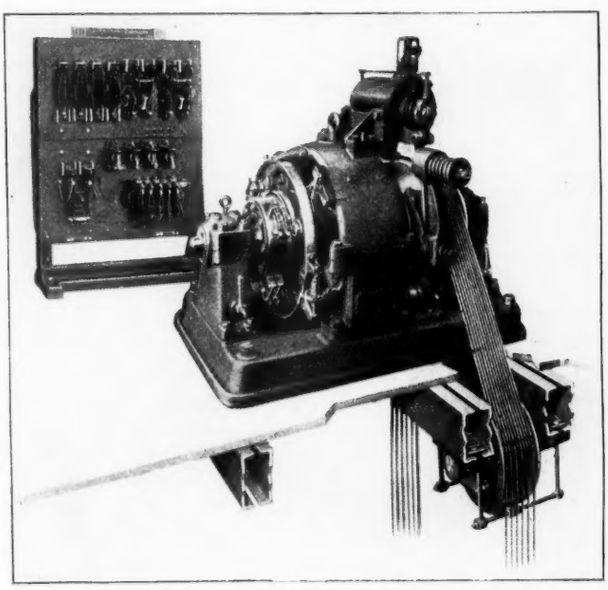


FIG. 2. GEARLESS TRACTION MACHINE ROPED 2:1

however, cause more wear than the two extra half-turns. Another question is the wearing of the V-grooves by the ropes; wearing of these grooves would result in loss of traction, and if the sheaves had to be replaced or recut frequently, this would be more objectionable than installing new ropes. The writer believes, however, that the V-groove gearless-traction elevator is a strong possibility of the future, as the machine can be built at lower costs than the standard type, owing to the downward pull on the driving sheave being only one-half that in the latter type. This results in a lighter sheave, a smaller-diameter armature shaft and bearings, smaller supports and lighter frame, and the secondary sheaves, with their bearings, supports, etc., are eliminated. In cases, however, where the V-grooved sheave does not span the distance from center of car to center of counterweight an idler sheave must be provided to lead off the ropes properly. This sheave can be of light construction compared to that of a secondary sheave in an equivalent standard installation.

The gearless-traction elevator has been developed to date for direct-current motor drive only. It is possible to build alternating-current motors to drive direct-traction elevators, but this has not been done because modern buildings requiring 550 to 700 ft. per min. car speed are all users of direct current.

Some modern buildings of medium height use alternating current, but all their requirements to date have been met with geared-traction elevators. Alternating-current direct-traction mine hoists have been built and put in operation, and when there is a demand for the alternating-current gearless type traction-elevator machine we may expect to see it supplied.

Duty To Warn Employee

Where a tar-boiling tank was connected with a high-pressure steam boiler for use in the process of melting the tar and there was a relief valve in the head of the tank, the owner is liable for injury to an employee while at work at the tank, resulting from the employer's negligence in failing either to see that the valve was open when live steam was being forced into the tank, or to warn the employee against the danger, which was unknown to him.

The injury resulted from overpressure of steam in the tank, causing the head to be forced off suddenly. (Iowa Supreme Court, Garren vs. Ottumwa Gas Co., 170 Northwestern Reporter, 428.)

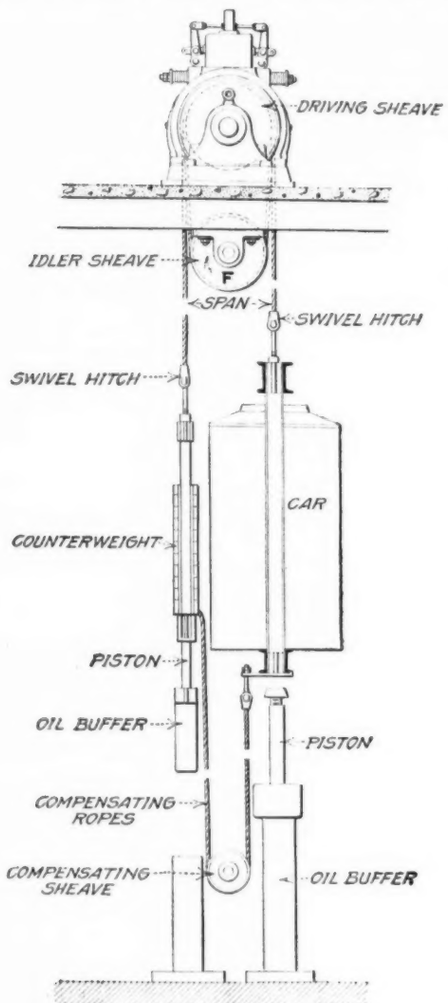


FIG. 3. DIRECT-TRACTION ELEVATOR MACHINE, 1:1 ROPING

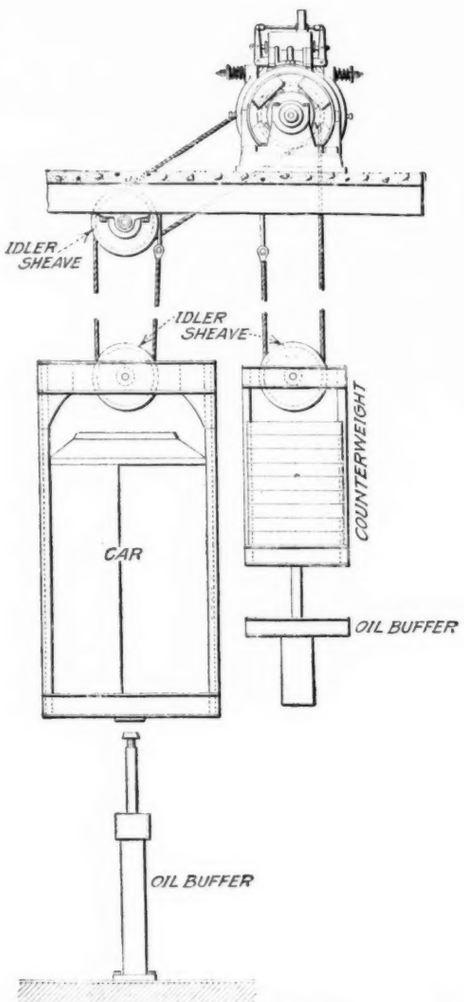


FIG. 4. DIRECT-TRACTION ELEVATOR MACHINE, 2:1 ROPING

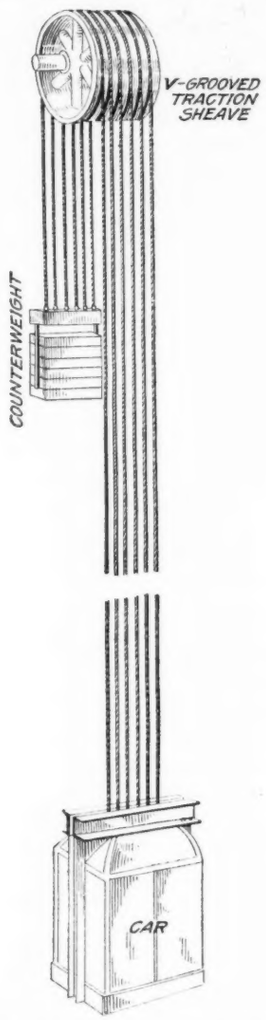


FIG. 5. V-GROOVED TRACTION ELEVATOR MACHINE

Pay your debt to Pershing's men. Buy Victory Liberty Loan Notes

OPERATION AT HOLTWOOD

Maintenance of the Governor Control System

By Charles H. Bromley

The fluid for actuating the governor-operating mechanism consists of filtered water, soluble oil and barium hydrate; its normal pressure is 275 lb. Many provisions are made against loss of the fluid pressure. Cooling coils in the governor-fluid reservoirs are cleaned every three months. Tanks and piping tested to 500 lb. to reveal weaknesses caused by corrosion. Extra-heavy galvanized pipe and gate valves with bronze parts are used.

THE pressure fluid for operating the governing mechanism is handled by a central pumping plant. The piping in this system is all extra-heavy steel, and all valves are extra-heavy and of the gate type. Formerly, the gates, toggles, yokes and stems of these valves were of cast iron; but bronze is now used, which obviates corrosion troubles. New extensions and replacements to the piping are made with galvanized pipe.

The fluid consists of filtered water with a certain admixture of barium hydrate and soluble oil. To each 250 gal. of filtered water one pound of barium hydrate is added and thoroughly mixed. This solution must stand eighty hours before it is admitted to the system—that is, to the sump tank. The barium hydrate acts as a neutralizing agent against the corrosive action of the river water. To give the solution lubricating properties 10 gal. of soluble oil to 30 gal. of filtered water are mixed and 2 gal. of this lubricant, or emulsion, is admitted daily to the sump tank, there being little leakage. A 30,000-gal. concrete tank on the stop-log gallery is used for mixing the barium solution.

The alkalinity of the fluid is tested daily by the hydraulic floorman, with phenolphthalein solution, which is a simple procedure, taking only a few minutes; he is seen doing this in Fig. 2. Several drops of the phenolphthalein are let into the test tube containing the fluid; if the fluid is slightly alkaline and not acid, the chemical turns it pink. A fluid that is just neutral may not be noncorrosive. Where the solution is very dilute, the dissolved salts may be so dissociated as to start and maintain the progress or corrosion. The carbon dioxide or the sulphuric-acid radical, or both, attacking the metal, combine with it, then separate, then attack again, the cycle being continuous. To avoid this action the aim is to maintain an excess of barium hydrate in the fluid.

F. W. Wood, of the Maryland Steel Co., diagnosed the corrosion troubles at Holtwood, and the engineers there are grateful to him for his investigations and the remedial measure suggested.

The sump tanks are the main reservoirs for the governor fluid and are kept nearly half-filled with fluid; the other half, or 60 per cent. to be exact, is filled with air. The pressure normally maintained on the fluid is 275 lb. per sq.in. The tanks have cooling coils through which cold water circulates to keep down the temperature of the fluid. These coils are drained and cleaned with air and water every three months, or oftener if indications show that they are covered with sludge.

While there is no definite time for testing the central pumping system for the governor-control mechanism, at least once every two years the piping, tanks, etc., are tested to 500 lb. hydrostatic pressure to detect fittings

FIG. 1. THE TAILRACE AT HOLTWOOD

and pipe weakened by corrosion. This test is usually given during the low-flow season, when a portion of the station is shut down for several hours in the morning. The system is sectionalized for this test and the air removed from the accumulator tanks under test to minimize the danger of explosion. The pressure is built up by a hand-operated pump.

As may be seen from the headpiece, the valves in the system are plainly numbered. The piping must of course be kept clear of sediment, sludge, scale, etc. The extent to which the sump tanks have sludge, scale, etc., deposited in them indicates how seriously the headers and piping may be affected. The deposit of sediment in the accumulator tanks gives one an idea of the condition of the headers. This is also apparent when the pumpman attends to the routine cleaning of the twin

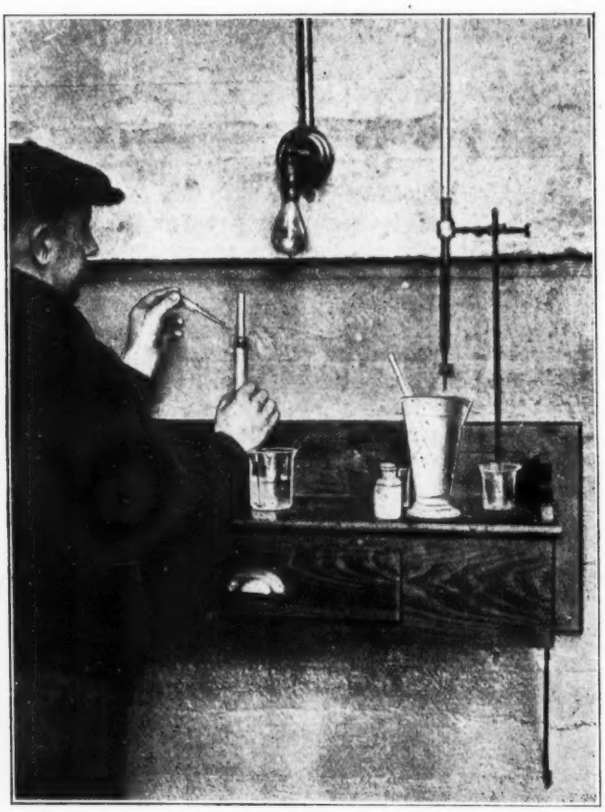


FIG. 2. HYDRAULIC FOREMAN MAKING DAILY TEST OF GOVERNOR-PRESSURE FLUID, DETERMINING ALKALINITY WITH PHENOLPHTHALEIN

strainers in the suction line between sump tank and governor pumps. For supplying water for cleaning, the 300-hp. pump is used and only one section is cleaned at a time.

To clean headers and piping, the valves in the balance pipe to the governor and hand control are closed, the governor pilot and regulating valves removed, and a tapered wooden plug driven into the valve side of the head cover. The valve chamber is closed by bolting the head cover to the chamber. This is to prevent the escape of fluid. The two valves on the accumulator tanks are now opened. The units dependent upon this part of the system for governor-operating pressure are operated by hand control—entirely separate from the governor-control system—if it is desirable to keep them in service during this cleaning period; the governor-header section valve is closed and the governor return-header valve to No. 1 governor sump tank opened. A governor pump is now started and the greatest possible quantity of water circulated for about ten minutes. If there is much sludge or sediment, the fluid in the sump tank will be discolored, turning from a milky to a brick color. The sump tank is next drained and flushed.

Close examination of the governor-regulating valve is made for scale, etc., before replacing it. As scale may be loose and washing about, the governor-regulating valve is carefully watched for some time after cleaning. The scale usually finds its way to the sump tank. Once every three months the check valves on the accumulator tanks are lubricated with waterproof graphite grease.

[Record forms, filled out by the chief machinist and kept in the office of the chief operator, tell at a glance when the system was inspected, what was done and by whom. These forms, together with the many others used at Holtwood, are the subject of an article on record keeping and follow-ups which will appear a few weeks later. An article to follow this present one on operation at Holtwood, which will appear soon, tells of the thorough way in which the submerged pins of the governor-operating mechanism are lubricated, and how the corrosion and rapid wear of these pins have been reduced to a negligible minimum.—Editor.]

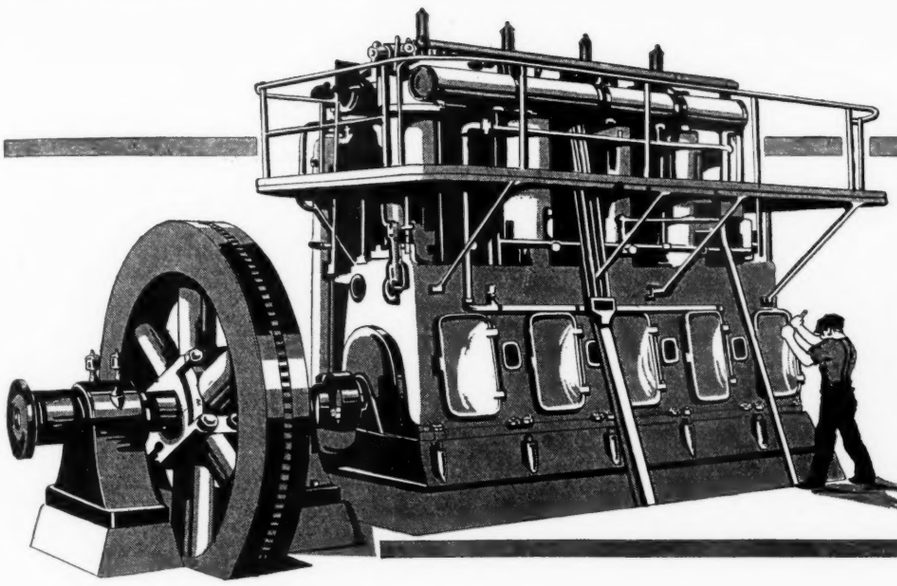
Improper Fusing of Circuit Caused Motor To Burn Out

By E. C. Parham

The main auxiliaries of a motor-driven feeder voltage-regulator equipment are the contact-making voltmeter and the relay switch. The voltmeter includes the contact-making parts of a direct-current generator voltage regulator. If the voltage varies a small percentage above or below standard, the voltmeter needle makes a contact that energizes one of the two operating coils of the relay switch, causing that switch to establish the proper circuit for rotating the motor in the right direction. The current handled by the contact-making voltmeter is very small, where that in the relay switch may be very appreciable if the motor or the regulator is out of order. As the pendulum contacts of the relay switch are spring-supported and as current passing through a spring tends to draw its temper, the springs of relay switches have soft-copper shunts connected in parallel with them.

A feeder regulator the frequency of operation of which had been gradually increasing for some time, began to blow fuses. At first the operator replaced the fuses with similar ones, but the blowings got to be so annoying that heavier ones were installed and finally, to avoid buying fuses, copper wire was wound around the fuse clips. The next stage of the progressive destruction was burning of shunts, contacts and springs, and it was at this stage that a complaint was made that the regulator "was not working right." An inspection, which then was about a year late, disclosed that the stator winding of the regulator motor was burned almost to a crisp and that there was no relief excepting to rewind it or get another one.

Occasional blowing of a fuse may be no reason for alarm; the fuse may have been defective or it may have been carelessly installed. Frequent blowing of apparently standard fuses, however, calls for an investigation.



Talks on DIESEL Engines

by L. H. Morrison

XVI—During the week the company had been conducting tests of fuel oil, preparatory to awarding the year's fuel-oil contract. So the men were prepared to hear a discussion of oil at the evening meeting.

"WHY do our three makes of engines act so different with the very same oil?" It was Kelly who fired this opening gun.

"Because the results obtained depend a great deal on the engine," said Egan. "If the oil is a little heavy, the compression will affect the combustion. If the compression pressure, and consequently the temperature, is low there isn't enough heat in the combustion chamber to ignite the oil thoroughly and the exhaust will be smoky because of unburnt carbon passing into the exhaust. Another evidence of the poor combustion will be the decreased horsepower. As to the high compression necessary to secure proper combustion of the heavier oils, it is well to bear in mind that this requires a higher injection pressure."

"Why so, chief?" asked Kelly, who was trying out one of Egan's cigars and was devoting most of his attention to that piece of "rope."

"A little exercise of your gray matter would prevent that question," retorted J. R., who rather objected to Kelly's cigar confiscation habits. "Can't you see that if the pressure in the cylinder is high, the air pressure must also be high to have the same pressure drop through the atomizer? If heavy oil is to be used, of course, the engine compression can be increased by inserting shims between the connecting-rod and the big end. But even with the compression high enough to burn this heavy oil, you must raise your injection pressure anyway. Before Kelly asks why, I'll say that the heavy oil has greater frictional resistance going through the atomizer, and a higher air pressure must be used."

"Well, chief," began Woods, "what kind of fuel oil do you recommend? I've just read a catalog, and it looks like that engine can burn any oil."

"Yes, I've read those catalogs, and they claim to burn anything from anthracite to buttermilk. But there is a lower limit as well as a higher limit to the gravity of oil that can be used continuously. I can take any oil that will flow through an inch pipe and make our engines handle it for a day; but I won't state definitely the length of time the engines will be down for cleaning the cylinders and loosening up the rings. The desirable oil is one that will burn clean, with no carbon deposits."

"How about kerosene, then, chief?"

"That is a reminder, Woods, of your old days of running a hot-ball engine. Kerosene is the thing in such a mill. With a Diesel engine it is too light and volatile. Even if the fuel-valve cage is water-cooled, it is pretty warm down close to the nozzle, and a good deal of the kerosene will vaporize. This is especially the case with an open nozzle. When the needle valve opens, the air pressure blows this gas into the cylinder without any 'braking' effect. We then have the ignition of a considerable mass of fuel gas, which will cause a knock or preignition pound. The engine has a tendency to run hot. This, of course, is due to the fact that most of the kerosene is injected at or before dead-center, which means less power production and more heat absorbed by the engine itself.

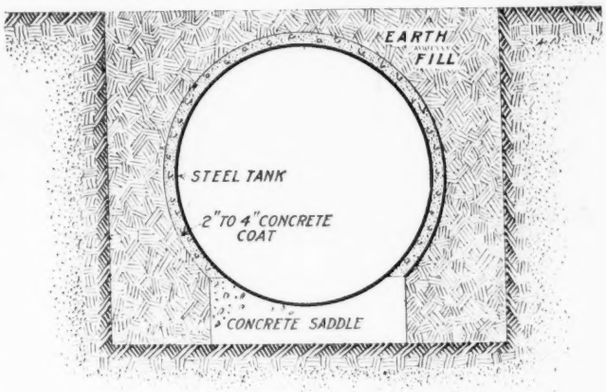


FIG. 1. PROTECTING A BURIED STEEL STORAGE TANK

In the next article the chief will describe various methods of cooling, forms of cooling towers and troubles that are caused by scale

"The same objection applies to the oil that is popularly known as distillate, having a gravity of from 36 to 44 deg. Baumé. I've found we have had more luck with the distillate known as desulphurized fuel oil. This has a gravity from 28 to 34 deg. Baumé, and while black in color, is clean and practically free from grit. It flows fairly freely, which is a boon in winter when

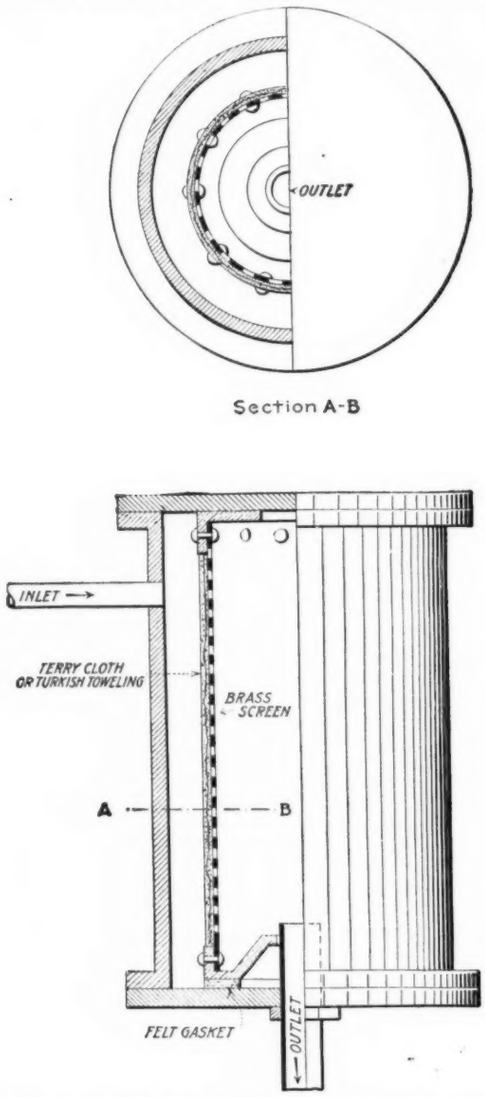


FIG. 2. HOME-MADE FILTER FOR FUEL OIL

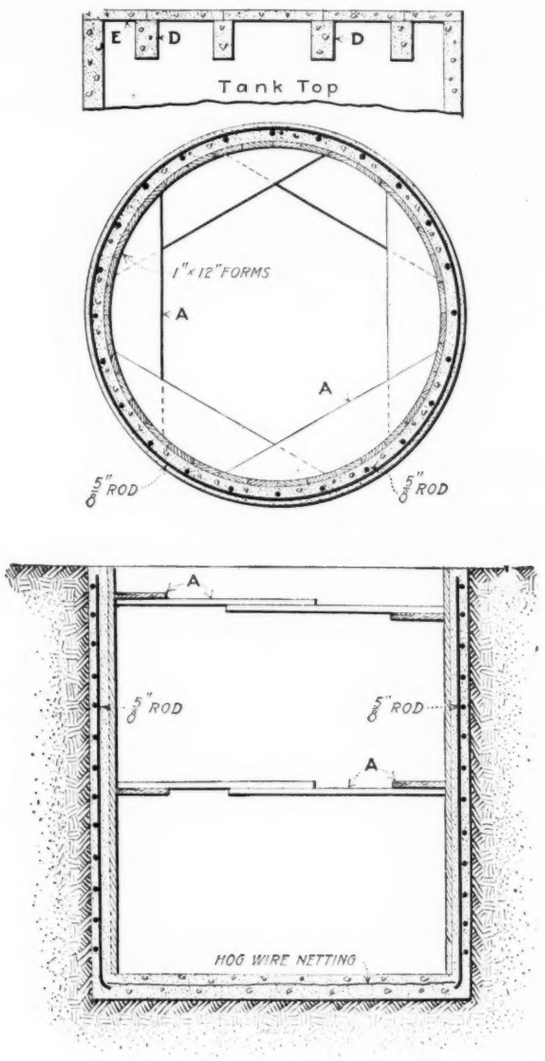


FIG. 3. CONSTRUCTION OF CONCRETE STORAGE TANK

the heavier oils are practically useless unless heating coils are used in the storage tank."

"What oil showed up best in the tests, chief?" Kelly inquired.

"The 28- to 34-deg. oil burned better, the exhaust showed clearer, and after a ten-hours' run the cylinders were clean, and the valves free from carbon. It will cost more per gallon than the 20-deg. oil that we tested the first day, but the amount used per year will be less and our repairs lots easier."

"How about that 'slop' which came from Mexico? I didn't fancy that when we ran it out of the barrels." It was Kelly that relieved himself of this caustic opinion regarding the fuel from our southern neighbor.

"Your taste, Kelly, for once was very good. I confess I was attracted by that cheap oil. I'd heard of several plants using it. We wrote to one plant, asking their experience, and the reply was favorable. During these tests I learned from the oil man that this identical plant was having trouble. It's strange how people always write good letters about a thing that they have been cussing ever since they had it. I remember the first gas engine I ever ran. It was about the worst piece of cast iron that ever had flywheels on it. But whenever anyone dropped in to investigate that make, I'd praise it to the skies, though I knew I was a liar. I don't know if it's because we want to be kind even to things we feel like damning or whether it's a desire to see another sucker bite. That is why I never care much for letters of recommendation."

"But what about that oil?" Kelly did not intend that his question should go unanswered.

"The trouble with that 14-deg. oil is that it gums up the engine. You know how much work we had cleaning the piston heads and loosening up the rings. Such an oil wouldn't do where an engine was to be fully loaded for hours at a time. It has no place in an engine unless used in connection with an ignition oil."

"What oil?" Woods was quick to inquire.

"In a minute, Woods, we'll look into what I mean by ignition oil. I believe you fellows should know what

oil we'll use this year. Here are the specifications: Heat value, not less than 18,500 B.t.u. per lb.; gravity at 60 deg. F., from 28 to 34 deg. Baumé; residue, not over 10 per cent. after a sample has been heated in an oven for 100 hours at 550 deg. F.; flash point, 160 to 220 deg. F.; burning point, 180 to 275 deg. F.; sulphur, not over 0.5 per cent.; water, not over 0.25 per cent.; and the oil to have an asphaltum base.

"There should be a filter between the storage tank and the engine tank. We use the home-made kind shown in Fig. 2. As you see, the top and the inside screen can be removed for cleaning without breaking a single pipe joint. By the use of two filters, one can always be at work. There is but one feature that requires care. Always be sure that the felt packing rings are in place when you insert the screen. This screen is made of perforated brass sheet and is covered with two folds or layers of terry cloth, although we are actually using Turkish toweling, since we have no real terry cloth."

"Mr. Egan, what sort of storage tank is the best?" Woods questioned, since it was evident Egan was through with his filter.

"If a plant is under 500 hp. a steel tank is best, I think. It is more expensive than a concrete tank, but the ordinary concrete man cannot build a leakproof tank. The size required will not justify securing an expert, and so the steel tank is the best to use."

"How about a wood tank?"

"A wood tank has one thing attractive about it—its low cost. But the low cost proves expensive in a year's time, owing to the rapid evaporation of the oil. No matter how low grade it is, there are some lighter portions, and the hot sun seems to draw these through the wood staves. I'd estimate a loss of at least 10 per cent.

"As to the steel tank, it doesn't pay to use too light a plate. The shell should be of $\frac{3}{16}$- or $\frac{1}{4}$-in. material and the heads should be $\frac{1}{4}$ in. thick. The longitudinal seams should be double-riveted, but the girth seams may be single-riveted. If a capacity of 8000 gal. is required, one tank will do, but for a greater capacity use two tanks. Then you have a chance to clean out the slime from one while the other is full."

"How about putting the tanks in the ground?" broke in Woods.

"By all means," said Egan. "If they are above ground, there is always a fire hazard, and the pipes are exposed to injury and meddling. Place them on concrete saddles in a pit about a foot deeper than the diameter of the tank, and pack earth in the pit, leaving about 4 in. between the dirt and the tank, as shown by the cross-section, Fig. 1. Then pour in concrete, covering the entire surface of the tank. If wooden forms are used, the concrete covering can be made as low as 2 in. thick. Of course, the concrete must be fairly neat to run through this narrow space. You then have a rust-proof storage.

"In making concrete tanks I favor the vertical cylindrical type. A good many square tanks have been built, but they all tend to crack at the corners. Some people say that if oil leaks into the surrounding dirt it will form a cement and prevent further leakage. The trouble is that a lot of oil is lost before this cement job is finished.

"It is easy to build a round concrete tank. Dig a circular pit of the necessary diameter and depth as shown in Fig. 3, and inside it build up a cylindrical form made of boards 1 in. by 12 in. held to shape by the segments *A*. Use hog wire netting to reinforce the bottom, insert the vertical reinforcing rods about 18 in. apart, and to them wire the circles, spaced about a foot apart. Then run in the concrete between the wooden form and the sides of the pit."

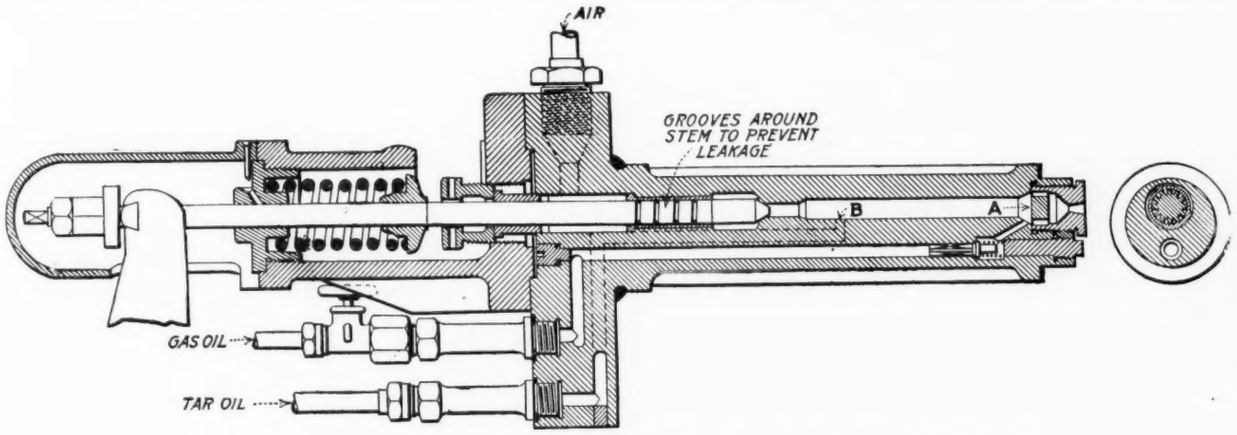


FIG. 4. SECTIONAL VIEW OF KOERTING NOZZLE FOR GAS OIL AND TAR OIL

"How about the top?" asked the Scotsman.

"That's the hardest part," said Egan. "Some use a wooden roof, but we covered ours with concrete slabs supported by reinforced girders. Our tanks were 12 ft. in diameter and 16 ft. deep, and we used four girders *D*, each 8 in. by 12 in. cross-section. To make them we built a wooden form having that cross-section and inserted twelve 1-in. iron rods to reinforce the concrete. We ran the girders of different lengths, to suit their position on the tank. The slabs *E* were not reinforced, but were grouted together, and the job was very satisfactory."

"Chief, you spoke of 14-deg. oil needing heating coils in the tank. I notice that our tank has coils, even if we do use light oil."

"That's a thing all storage tanks should have. It makes the fuel easier to handle and no steam boiler is needed. There are two ways to operate the coils without a boiler. The first method is to operate the engine cooling-water system under pressure, or, as it is called, use a closed system. By arranging the necessary regulating valves, part of the discharge can be bypassed

through the tank coils. It takes a good while to get the oil up to 120 deg. F., but once it is warm the coils will keep it up to this temperature. The second method is to arrange a jacket about part of the engine exhaust pipe. Connect this to the overhead water tank, using a check valve in the line. Run the other end to the coils, and then arrange to discharge the coils into the cooling-water sump. By cracking the regulating valve a slight amount a circulation of hot water is set up.

"If you ever put in an outfit, use a lot of pains with the oil piping. Every joint should be threaded carefully and made up without any red lead or other compound. Remember that oil will leak at joints that are watertight. Never use anything but heavy-pattern brass valves with nickel seats and valve disks.

"A very important adjunct to every Diesel plant is a starting tank of kerosene. Even with a good grade of fuel oil it's hard to start an engine on cold mornings. Using kerosene for the first five minutes will bring the engine up to speed quickly and warm up the combustion chamber and valves."

"Now, chief, what did you mean by ignition oil?" Woods inquired.

"Well, as I stated, low-grade oils, such as Mexican, ignite slowly. If an engine runs at 180 r.p.m., there are three revolutions per second. If the period of combustion is 10 per cent. of the piston stroke, it cannot exceed $\frac{1}{30}$ of a second. "When you recognize that the beginning of the injection of the fuel and its atomization are necessarily slow and consider the time spent in mixing the atomized fuel and the air, as well as the cooling effect of the injection air, it is evident that there are many factors that tend to retard the combustion. Even with a high-grade oil this period is none too long.

"Low-gravity oil demands a longer time in which to be atomized, mixed with the air charge and ignited. The oil particles are larger than in the case of light oils and the actual time of burning is longer. To allow a very low-grade petroleum oil or tar to be burned, one of several methods must be adopted. The first method is to heat the heavy oil or tar to a temperature around 200 deg. F. and to raise the injection-air temperature to avoid any chilling action during the atomization of the charge. This method is fairly satisfactory with oils above 16 deg. Baumé, but with lower grade oils and tar I've never heard of any plant using this successfully.

"The second method is a variation of the first. The oil is heated and a small amount of gas oil of from 25 to 35 deg. Baumé is mixed with it in the storage tank. It's practically impossible to keep the two oils thoroughly mixed without resorting to some form of mechanical agitator. In one plant a motor-driven paddle wheel such as is found in a brine-cooling tank was employed. The light oil thus added is called an ignition oil. Its purpose is to supply a fuel that will ignite quickly, raise the cylinder temperature and produce a flame. This plan works with any petroleum fuel, but is not very good when tar oil is used. In tests using mixtures of tar oil and gas oil it has been proved that 25 per cent. of tar oil and 75 per cent. of gas oil is the best mixture when the engine is to operate on a varying load. If the engine is to develop full load all the time, a 50-50 mixture can be used, because a high temperature is maintained. Consequently, it would be advisable to use gas oil for low and half loads, reserving the use of the tar mixture for three-quarters and full loads only.

"Another method involves the use of a small amount of gas or solar oil that is deposited close to the nozzle and blown into the combustion chamber ahead of the tar oil. The oil ignites at the ordinary Diesel temperature and provides a flame to positively ignite the tar when it enters the combustion chamber. This plan demands a fuel valve that has separate tar-oil and gas-oil connections, as well as separate fuel pumps. In the Koerting valve in Fig. 4, the ignition oil is deposited at *A*, just behind the nozzle plate, and the tar at *B*, and as the valve opens the air blast blows the ignition oil in ahead of the tar."

The Electrical Study Course—Types of Three-Wire Generators

Discusses the various types of generators that can be used for three-wire service, and brings out the differences in operation that must be observed and the points that require attention when making field-coil connections.

THE discussion regarding three-wire generators that has preceded the present lesson was confined almost entirely to a consideration of two-pole machines, and nothing was said regarding the method of excitation to be used. A brief summary of the various types of machines that can be used for the purpose will therefore be given.

In the first place it is to be understood that, as in other direct-current generators, the armature is drum-wound and not ring-wound, as indicated in the diagrams used throughout the discussion. As previously explained, the ring type of representation was employed merely in the interest of clearness of presentation. The armature winding, therefore, does not differ from that which would be used in any direct-current generator of the same voltage, the only difference between the armature of an ordinary two-wire generator and that of a three-wire generator being that the latter is provided with slip rings in addition to a commutator, and that these rings are connected to points on the winding that are diametrically opposite one another.

Since the object of the three-wire generator is to supply current at a constant voltage, it must be of the constant-voltage type. It was found at the time that generators were under discussion that there are two types that may be classed as constant potential; namely, the shunt and the compound. It follows that three-wire generators may be of either of these two types. As in the case of two-wire generators, the

compound type is the one used most extensively, since the voltage is not only self-governing, but by suitable overcompounding can be made to increase with increase of load in order to compensate for the voltage, or so-called *IR*, drop in the mains, thereby maintaining a constant voltage at the load itself. Moreover, just as in shunt and compound two-wire generators, inter-

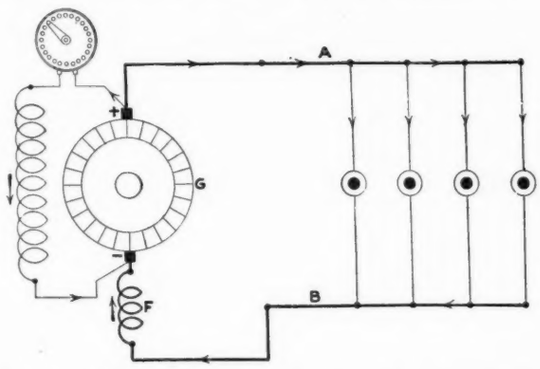


FIG. 1. TWO-WIRE COMPOUND-WOUND GENERATOR CONNECTED TO A LOAD

poles may be used in three-wire machines and are so used. The choice of the number of poles is a matter of design as it is in the two-wire generators, and there is no condition met with that does not also figure in the two-wire type.

In the case of a compound three-wire generator there is one complication to which attention must be drawn. Referring to the connections for a two-wire generator of this type, such as illustrated in Fig. 1, it is clear that whatever current flows in one main *A* must also flow in the other one *B*, and therefore all the current delivered by the armature *G* must flow through the series field *F*.

Consider, now, the case of a three-wire generator connected to a three-wire system, as illustrated in Fig. 2. When the system is balanced there will be no current in the neutral *N* and the current in *B* will be the same as that through *A*, and the conditions will be the same as in the two-wire system of Fig. 1. Assume, now, however, that the load is unbalanced; for example, that more lamps are turned on at *X* than at *Y*. There will then be less current in *B* than in

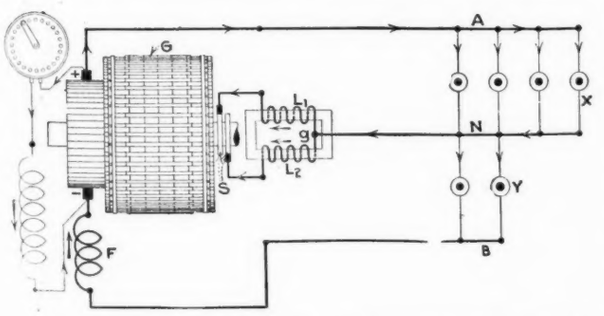


FIG. 2. THREE-WIRE COMPOUND-WOUND GENERATOR; SERIES-FIELD WINDING IN ONE SECTION

A, and consequently less current through the series field *F* than is delivered by the armature *G*. The extreme case would be that in which all the lamps at *X* were turned on and all those at *Y* turned off. There would then be no current through *B* and therefore none through *F*. That is, although the generator would be delivering half its rated output, there would be no current through its series field and consequently no series-field magnetic flux to keep the voltage from dropping with increase of load. In other words, the machine would behave as a shunt instead of as a compound generator.

On the other hand, if all the lamps at *Y* were to be turned on and those at *X* were all to be turned off, there would be no current in *A*, and *B* would carry full-load current, causing full-load current to flow through *F*. The series-field excitation would therefore be the same as it would be if all the lamps in both *X* and *Y* were turned on, and it would give as much compounding in the one case as in the other.

To overcome these disadvantages it becomes necessary to connect one half of the series-field winding into one side of the circuit and the other half into the other side, as F_1 and F_2 in Fig. 3. This offers no difficulty, since there are always at least two poles, and since each pole has its share of the series-field winding wound upon it. With this arrangement the currents in *A* and *B* each produce the correct amount of magnetization. Thus, if load *X* is maximum and load *Y* zero (in which case the load on the generator is 50 per cent. of normal), full-load current will flow through F_1; or if *X* is zero and *Y* is maximum the same conditions hold except that the current passes

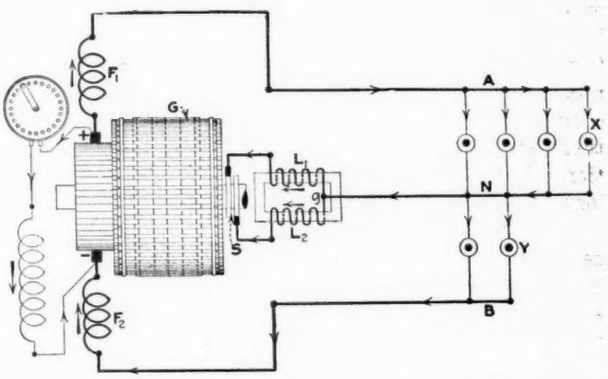


FIG. 3. THREE-WIRE COMPOUND-WOUND GENERATOR; SERIES-FIELD WINDING IN TWO SECTIONS

through F_2. In either case the series-field effect is due to full-load current passing through half the total series-field winding, and therefore has approximately only half the effect that would be present if full-load current were to flow through the entire series-field winding.

When both *X* and *Y* are loaded the maximum amount, the generator carries full load and full-load current flows through *A* and *B*, causing full-load current to flow through both F_1 and F_2; that is, causing full-load current to flow through the entire series-field winding and therefore giving the full series-field effect. If the machine is a multipolar one it would be necessary to connect alternate series-field windings in series somewhat as shown in Fig. 4, which represents the connections for the series-field windings of a six-pole compound-wound three-wire generators. (The shunt-field windings are not shown.)

The argument in reference to series windings applies equally to those on interpoles. That is, when a three-wire generator is of the interpole type, half the interpole windings must be connected into one side of the system and half into the other, otherwise there would be times when too little current would flow through them

and others when there would be too much. The distribution of the windings can be accomplished in the same manner as with the series windings; namely, by connecting alternate ones in series and then connecting one group to the positive armature terminal and the other to the negative one.

If the machine is a compound one, each group of interpole windings would of course be connected in

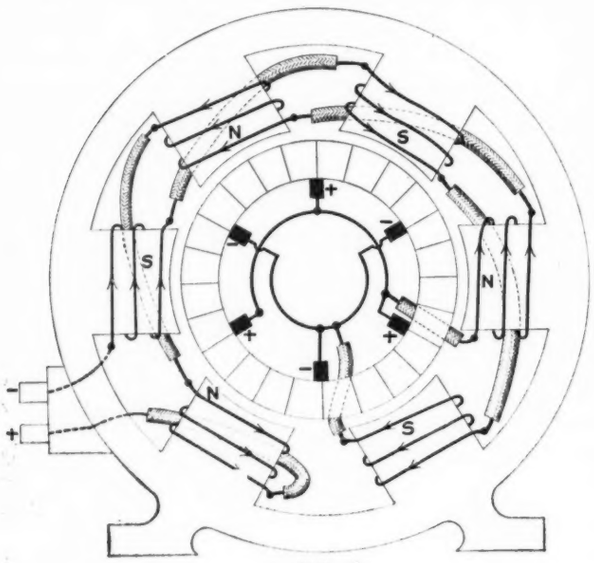


FIG. 4

series with one group of series-field windings. In connecting up the series and interpole windings of such machines, great care must be exercised to make the connections in such manner that the magnetic poles created by the current through them shall have the correct polarity. If the poles created by the shunt-field winding are those indicated by N and S in Fig. 4, the connections for an interpole machine would have to be those of Fig. 5 if the direction of rotation is that indicated by the arrow K. If the direction of rotation were the reverse, as indicated by the arrow K in Fig. 6, the connections would have to be changed to correspond to those shown in that figure. It is to be noted that in the latter case the polarity of the brushes would be the reverse of what they were in the former, which fact must be taken into account in making the connections between the fields and the brushes.

In the problem of the preceding lesson it was required to compute the voltage across each of two resistances connected in series to a source of 110 volts, as indicated in Fig. 7. It was furthermore required to determine the voltages that would be indicated by a voltmeter whose resistance is 14,372 ohms, if it were to be connected across each of the resistances in turn.

The actual voltage across each resistance would be equal to the current through it multiplied by its resistance. Since they are in series, the current through each is the same, and if we represent it by I, and the voltages across R_1 and R_2 by E_1 and E_2 respectively, we have, $E_1 = IR_1$ and $E_2 = IR_2$. The current I is equal to the sum of R_1 and R_2 divided into the voltage across them; namely, 110 volts. That is, $I = \frac{110}{R_1 + R_2} = \frac{110}{6000 + 2500} = 0.012941$ ampere. Substituting in the expressions for E_1 and E_2, we have, $E_1 = IR_1 = 0.012941 \times 6000 = 77.65$ volts, and $E_2 = IR_2 = 0.012941 \times 2500 = 32.35$ volts. That our computations are correct is shown by the fact that the sum of the voltages is equal to the total voltage; that is, $77.65 + 32.35 = 110$ volts. Placing a voltmeter whose resistance is 14,372 ohms across R_1 is equivalent to changing the conditions to those represented

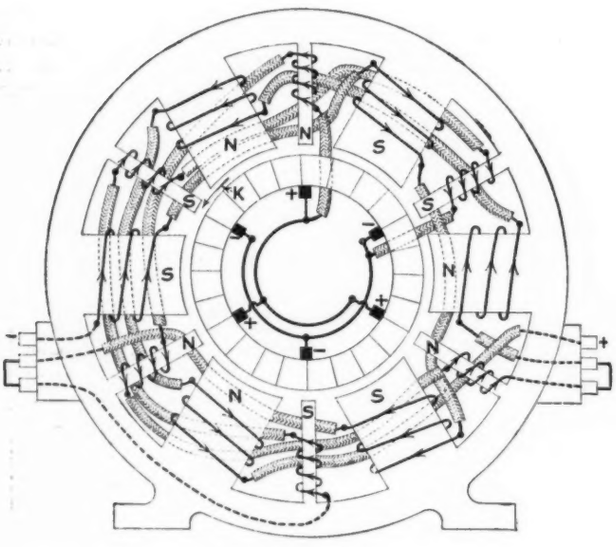


FIG. 5

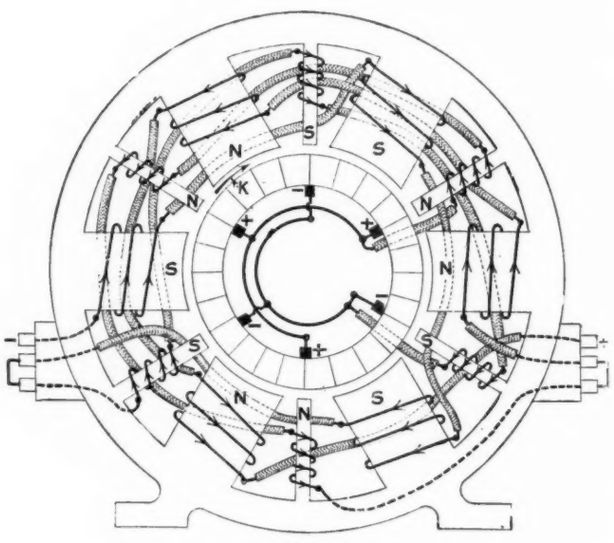


FIG. 6

FIGS. 4 TO 6. SERIES- AND INTERPOLE-FIELD WINDING CONNECTIONS FOR THREE-WIRE GENERATORS

in Fig. 8, in which R_v represents the resistance of the voltmeter. The voltage across ac will now be equal to the combined current through R_v and R_1 multiplied by their joint resistance. If we let I_t represent the total current and R_p the parallel resistance, we have, that $E_1 = I_t R_p$.

We first find the value of R_p, which we get from the relation $R_p = \frac{1}{\frac{1}{R_1} + \frac{1}{R_v}} = \frac{1}{\frac{1}{6000} + \frac{1}{14372}} = 4232$ ohms. Then I_t is found by dividing $R_p + R_2$ into the voltage across the two (namely, 110 volts), accord-

ing to which, $I_t = \frac{110}{R_p + R_2} = \frac{110}{4232 + 2500} = 0.01634$ ampere; from which we have, $E_1 = I_t R_p = 0.01634 \times 4232 = 69.15$ volts. When the voltmeter is connected across R_2 the same course of reasoning would be followed and we would in that case have $E_2 = I_t R_p$, where $R_p = \frac{1}{\frac{1}{R_v} + \frac{1}{R_2}} = \frac{1}{\frac{1}{14372} + \frac{1}{2500}} = 2130$ ohms, and $I_t = \frac{110}{R_p + R_2} = \frac{110}{2130 + 6000} = 0.01353$ ampere, making $E_2 = 0.01353 \times 2130 = 28.82$ volts.

It is thus apparent that the voltmeter readings could

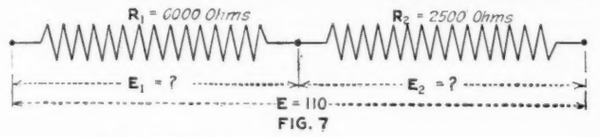


FIG. 7

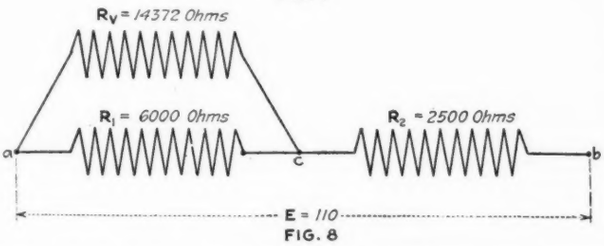


FIG. 8

FIGS. 7 AND 8. RESISTANCES CONNECTED IN SERIES

not be depended upon to give the actual voltages existing across the resistances at the time the voltmeter is not in use. Thus, the actual voltage across R_1 is 77.65 volts, whereas the voltmeter would read only 69.15 volts; and the actual voltage across R_2 is 32.35 volts, whereas the voltmeter would indicate only 28.82 volts. These discrepancies are due to the fact that the resistance of the voltmeter is not very great as compared with the resistance of R_1 and R_2. When its resistance is very great in comparison (as it usually is), the readings are correct. This will be made clear in the solving of the following problem:

Suppose R_1 to be 7 ohms and R_2 to be 15 ohms. What would be the voltage across each? What would the voltmeter read if connected across each in succession?

Specification for Leather Belting

By H. E. Weightman

Coal and equipment for the power plant are commonly bought under specifications, but the men in the smaller plants have not had the necessary data or the talent to write up a good specification for leather belting. In view of this state of affairs, the following is submitted, in the hope that it will give valuable information and serve a useful purpose. It was written in 1909 and changed from time to time as experience indicated. But no changes were made until thorough investigation and fair trial showed them worthy of being incorporated in the specification.

Manufacture—The quality and preparation of the leather and the methods and workmanship used in the manufacture of belts or belting ordered under this specification shall be such as to insure the qualities called for in the completed product.

Inspection—The Blank Company reserves the right to reject any belt or belting which does not conform to the requirements of this specification. In addition to the inspection which will be made on each belt, the right is reserved to reject any belt which develops, after it has been put in service, evidence of inferior material, improper methods of manufacture or poor workmanship, or when it is shown that a belt does not conform with the requirements of this specification.

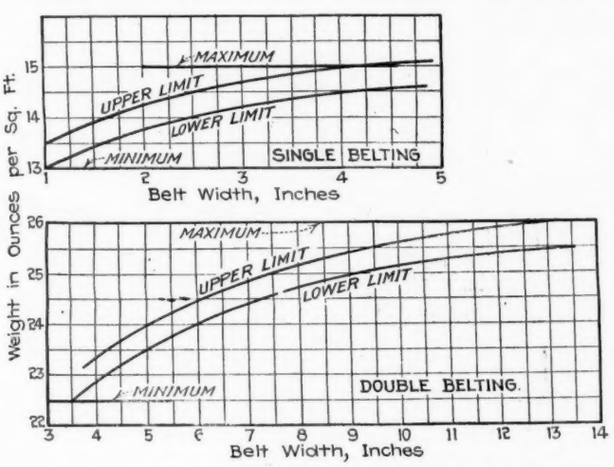
Guarantee—Any belt which is rejected under any of the conditions covered under "Inspection" shall either be repaired or replaced promptly by the manufacturer free of any charge to the Blank Company, or upon its return to the manufacturer full credit shall be allowed the Blank Company, for the cost of the belt. The choice of action in this case rests with the manufacturer.

Material—All leather used in the manufacture of belts furnished under this specification shall be made of No. 1 native packer steer hides from which all shoulder and flank stock has been removed. The leather shall be of what is known as "center stock." The strips shall be cut parallel to the direction of the center of the backbone.

Uniformity—Uniformity in thickness must be obtained by selecting plump, even stock and not shinning or filling for double belting and splitting or shaving for single belting.

Preparation—All leather shall be tanned thoroughly with pure oak bark by the process of tanning in cold liquors. Each individual piece shall be stretched until the elasticity is removed.

Construction—All belting shall be made strictly short lap containing sectional pieces longer than 50 in. cut from the center portion of the hide. The backbone markings in the hide shall be discernible in all finished belts 10 in. in width or wider and in the case of double belts on both sides. In double belting less than



LIMITS OF WEIGHT FOR LEATHER BELTING

10 in. in width the two pieces which are cut from relatively the same position on the two sides of a hide shall be placed together to form the two sides of the same part of the belting. They shall be placed together in such a way that the head end of the strip on each side of the belt will be against the butt end of its mate on the other side. All connecting shall be done under hydraulic pressure.

Weight—The weight of belting shall be within the limits given on the attached curves.

Finish—All belting shall be finished without oil dressing and without rivets, pegs or other fasteners.

The Compound Air Lift

By A. W. ALLEN

In this article a compound air lift is described, constructed from piping and fittings which will again be available for ordinary use when a pump is installed or the water is allowed to rise.

THE compound air lift is suitable where objections may be raised against the construction of a sump of sufficient depth to satisfy the efficiency requirements of an ordinary single lift. It is also applicable when the available pressure of air is low. The depth of the various stages can be adjusted in this particular, but it must be remembered that a very low available pressure is likely to cause unnecessary complications in the arrangement by introducing too many units. This necessitates a proportionally

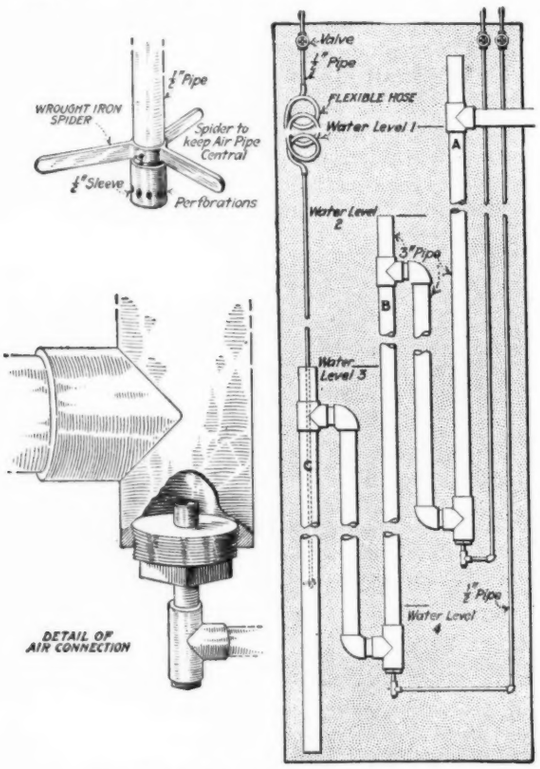


DIAGRAM OF COMPOUND AIR LIFT

large number of pipe fittings and increases friction. Under such conditions the system is not recommended, although exceptional cases may call for exceptional methods of treatment.

Fundamentals of a Compound Air Lift

A compound air lift is merely two or more simple air lifts arranged in series—the rising main of the first discharging into the sump of the second and so on. A loss of fall at each stage is inevitable, and this also involves a small loss of power. The system can be arranged to duplicate or triplicate any of the ordinary designs in use; and the customary self-regulating features can be incorporated in each of the various units.

I once had occasion to utilize the compound air-lift principle under somewhat unusual circumstances. An old mine working had to be dewatered to drain an adjoining shaft. The old working had to be drained as far as possible by a system that made personal attention near the water level unnecessary.

A small compressor furnished air at a low pressure, and even if a pump could have been made to do the work, there would continually have been the danger of interment of both the pump and anyone who happened to be attending to it. A compound air lift was therefore constructed, which permitted the gradual lowering of the water to a level in proportion to the depth of successive submergences, and so personal risk was eliminated. Soundings disclosed the fact that timbers had collapsed to such an extent that only a narrow channel remained in one place. This was found sufficient, however, to permit the passage of the lift pipes.

A somewhat diagrammatic drawing of a compound lift of this class is shown in the illustration, but in actual construction it is, of course, possible to bunch the various pipes and so insure greater compactness than is indicated. Strainers, attached to the foot of the lowest lift and at other necessary points, are advisable and should be made of ample dimensions to obviate any throttling of the intake.

The need for the constant shifting and readjustment of the pump, as the water lowers, can be avoided by constructing the apparatus complete and by placing it at the lowest point in the first instance; and then by pumping the water in stages. The various pipes can be assembled and the added sections bolted or screwed together as the pump is lowered. Permanent air connections are indicated, but can be omitted when it is considered preferable, and flexible connections used instead. The permanent connections were available, in the instance under description, only when the pressure had been reduced by the help of the flexibly connected air pipe.

Permanent Air Connections

It will be noticed that the permanent air connections are attached through a plug at the lower arm of a T-piece in each case. This design was purposely adopted to minimize friction, as it was found that the extension of the air pipe into the rising main served no useful purpose and, furthermore, constricted the suction of the pump. By arranging the supply as shown, it was found that there was no tendency for the air to escape other than where it was needed, except when an unnecessary volume was being used.

There is one disadvantage in the use of the flexible air connections and a loose pipe system, apart from the fact that the introduction of another pipe in the rising main increases the frictional resistance, and that is due to the fact that the air pipe may rest against the side of the lift pipe. This will result in a partial distribution of the air through the liquid. The objection may be of little account in the case of small lifts, but should be avoided in large ones. The ill effects may be reduced by bolting a "spider," of three arms, to the outside of the air pipe, near the bottom, which

will maintain it in a central position (see illustration). The arms must be of such a length that the "spider" forms a very loose fit in the inside of the rising main. It is preferably made of wrought iron and is kept from slipping off at the bottom of the pipe by means of a sleeve which may be bored around its lower end, in the manner shown, in order to distribute the air more effectively.

Operation of Compound Lift With Flexible Air Connections

By reference to the diagram it will be seen that four water levels are given. It may be assumed that level No. 1 shows the original position of the water. The flexible air connection is then put into the rising main *A* to a depth consistent with available pressure, and gradually lowered therein as the water is reduced in the shaft until level No. 2 is reached. The flexibly connected pipe is then withdrawn from the rising main *A* and transferred to *B*. As soon as the second lift is in operation, water will be delivered so that lift *A* can be operated by means of the permanently connected air pipe. As soon as water level No. 3 has been reached, the flexible connection is withdrawn from air lift *B* and transferred to *C*. As soon as this is in operation, the permanent connection to supply air for lift *B* can be used. The final water level will be approximately as shown at No. 4, with the air pipe at the bottom of the lowest lift pipe.

Ratio of submergence to lift will vary in such installations according to local conditions. Economy in small lifts may demand a ratio of from 1½ or 2 to 1 of submergence as compared with the lift. In other instances economical work is of secondary consideration, especially where the air pressure is low, and a shallow submergence may be adopted.

The arrangement shown permits the easy escape of the air when lifting is accomplished. Spasmodic or jerky delivery of water usually indicates faulty conditions as to air volume or submergence ratio, which should be regulated as far as practicable to insure a more or less even stream from the discharge pipe.—*Engineering and Mining Journal.*

Boiler Patches and Diagonal Joints

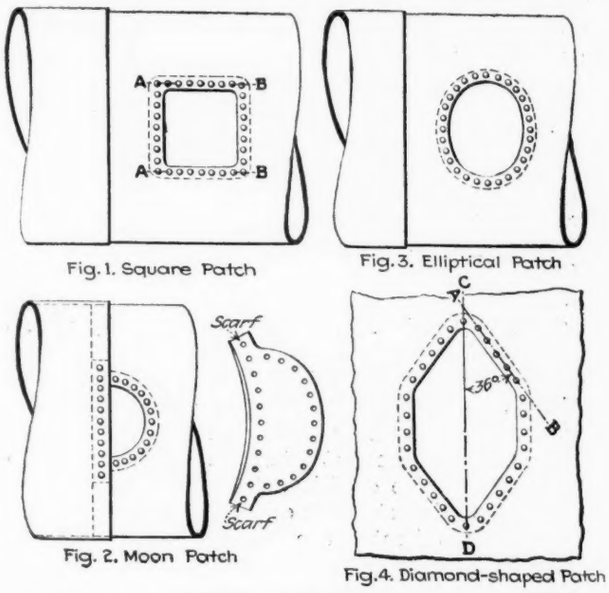
By C. B. Linstrom

Good judgment must be exercised to determine the best and most economical means of making boiler repairs so as to insure that the affected parts will withstand the working conditions to which the boiler is subjected. One of the most frequent repairs met with is the application of boiler patches. Patches may be applied on either the outside or the inside of cylindrical shells or tubular, Scotch marine and locomotive boilers, or on drums of water-tube boilers. It is not the practice to place patches on the outside of shell plates directly exposed to the fire.

Another repair often met with is that of bagged or bulged shell courses. Such deformations occur at the bottom of the shell in tubular boilers and are due to the overheating of the plate. Accumulation of sediment and scale forms a mass that prevents the water from coming in direct contact with the metal, and the result is overheating. A small bag can be repaired by reheating the part affected and driving it back, but in some cases the damaged section of the plate is removed and a patch is applied. A bulge extending over a large area cannot be handled in this way. The only recourse in such a case is to apply a new plate section to the shell course.

Boiler patches are made in various shapes, and they should be so designed as to give the strongest seam possible. A patch of the form shown in Fig. 1 is undesirable, as the seams *AB* are horizontal, giving a very small joint efficiency when single-riveted. The one in Fig. 2 is a half-moon patch and is commonly applied between shell courses along the girth seam. Fig. 3 is an elliptical patch and Fig. 4 a diamond-shaped patch. The seams in Figs. 2 to 4 are diagonal and are stronger than seams of like proportions when arranged as at *AB*, Fig. 1.

For a given pressure the stress per inch of joint in a boiler is twice as great in the longitudinal seam as in the girth seam; consequently, the efficiency of the girth seam need be only half as great as the efficiency of the longitudinal seam. This explains why girth seams are



FIGS. 1 TO 4. FORMS OF PATCHES USED ON BOILER SHELLS

usually single-riveted. The ratio of the stress on the seams being 2 to 1, it is evident that a diagonal seam of the same proportions as a horizontal seam will have an effective efficiency lying between the efficiency of the longitudinal seam and its efficiency if it were a girth seam. Therefore, the effective efficiency will vary according to the angle the diagonal joint makes with the girth seam, and the nearer it approaches the position of the girth seam the stronger it becomes.

To calculate the efficiency of a diagonal joint, first determine the joint efficiency as for a longitudinal seam; then multiply the result so found by the factor corresponding to the angle the seam makes with the girth seam, which is found by the formula

$$Factor = \frac{2}{\sqrt{3 \times \sin^2 A + 1}}$$

in which A represents the angle that the diagonal seam makes with the girth seam. To obviate the use of the formula for each individual problem, the table has been worked out, giving the values of the factor corresponding to various values of the angle A.

To illustrate the calculation of a diagonal-joint effi-

ciency, consider the arrangement of the seam and patch in Fig. 4. The joint is a single-riveted lap seam, diameter of driven rivets $\frac{13}{16}$ in., plate thickness $\frac{3}{8}$ in., pitch of rivets 2 in. Assume 38,000 lb. per sq.in. as the shearing resistance of the rivets and 55,000 lb. per sq.in. as the tensile strength of the plate.

First determine the joint efficiency as for an ordinary longitudinal seam, using as a basis a length of joint equal to the pitch, or 2 in. The tensile strength of

FACTORS FOR FINDING EFFECTIVE EFFICIENCIES OF DIAGONAL JOINTS

Angle A Deg.	Value of Factor	Angle A Deg.	Value of Factor	Angle A Deg.	Value of Factor
30	1.51	42	1.31	54	1.16
32	1.47	44	1.28	56	1.14
34	1.44	46	1.25	58	1.13
36	1.40	48	1.23	60	1.11
38	1.37	50	1.20	62	1.09
40	1.34	52	1.18	64	1.08

solid metal in a strip of this length is $55{,}000 \times 2 \times \frac{3}{8} = 41{,}250$ lb. The strength of the metal between rivets in one pitch is $(2 - \frac{13}{16}) \times \frac{3}{8} \times 55{,}000 = 24{,}492$ lb. Then the efficiency of the net plate section as compared with the solid plate is $24{,}492 \div 41{,}250 = 59.4$ per cent.

The rivet efficiency, which must also be considered, is determined by finding first the strength of the rivets to resist the shearing and crushing stresses and then dividing the value so found by the strength of the solid plate section. The smallest efficiency found for the joint is the one to be used in determining the pressure to be allowed on the seam.

The strength of the rivets to resist shearing is found as follows: Area of driven rivet $= (\frac{13}{16})^2 \times 0.7854 = 0.5185$ sq.in. Then, $38{,}000 \times 0.5185 \times 1 = 19{,}703$ lb., shearing resistance, and the rivet efficiency is $19{,}703 \div 41{,}250 = 47.8$ per cent.

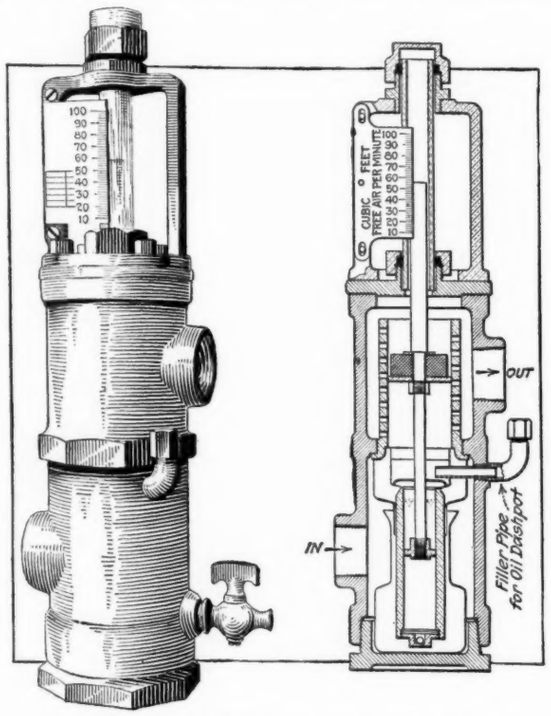
The joint may fail by crushing of the plate in front of the rivets, so the strength of the plate section to resist crushing should also be found and the efficiency of the joint in this respect determined. Assume 95,000 lb. per sq.in. as the crushing strength of boiler steel. Then, the crushing strength of the metal in the cross-sectional area in front of one rivet is $\frac{13}{16} \times \frac{3}{8} \times 95{,}000 = 28{,}945$ lb., and $28{,}945 \div 41{,}250 = 70$ per cent. efficiency of joint to resist crushing of metal in front of one rivet. The smallest efficiency is that of the rivets, which is 47.8 per cent.; therefore the diagonal-joint efficiency is determined from this value. The factor for the diagonal seam *AB*, Fig. 4, which in this case makes an angle of 36 deg. with the girth seam *CD*, is found from the table to be 1.40. Then, $47.8 \times 1.40 = 66.9$ per cent., the efficiency of the diagonal joint.

New Jersey Air Tool-om-eter

The volume of a definite compressed fluid or gas flowing under small constant head through multiple orifices of the same shape and size is directly proportional to the number of orifices exposed to the flow. This is the principle upon which the New Jersey air tool-om-eter is designed. This meter, manufactured by the New Jersey Meter Co., Plainfield, N. J., shows direct on a scale, in cubic feet of free air a minute, the flow of air in a pipe. It is capable of measuring the air consumption of any machine or application of compressed air and the actual net production of air by any compressor or pump within its capacity.

In operation, a small head or difference of pressure is established between the interior of the cylinder and the outlet chamber, this pressure difference (but a few ounces per square inch) being fixed by the exact weight of the moving element and the area of the pistons on which the difference of pressure acts. The moving element rises until the weight is exactly supported by the difference in pressure; the pistons and rod are then floating in static balance in a position corresponding to the volume of the air flowing, the number of holes exposed and the height of the top of the rod in the sight glass. The meter automatically adjusts itself to the conditions required by the principle, or natural law, as already stated. The divisions of the scale plate are calipered by comparison with a standardized instrument to read correctly.

This instrument is not a velocity meter, which would give readings proportional to the square of the volume flowing, but is a direct volume gage with a uniform scale



EXTERIOR AND SECTION OF TOOL-OM-ETER

on which one cubic foot is represented by the same distance whether working at low or at high capacity. A sectional view of the instrument is shown.

This meter will detect and measure leakages in air lines, valves, hose, etc., determine the net volume of air produced by compressors for comparison with nominal rating or displacement and show where the air goes after it is compressed.

The meter has but one moving element, which floats on the air and is practically frictionless and nonwearing.

Alcohol can be made from starches, sugars, wood waste, sulphite liquors from paper manufacture, peat, cornstalks and various other materials. It has been estimated—on a pre-war basis—that alcohol will compete with gasoline as a commercial fuel when the cost of gasoline goes above 35c. a gallon.

Some firemen regulate the draft by kicking the ashpit doors open or shut at intervals. The proper way is to regulate the draft by the damper, which, by the way, is easier on shoe leather.

EDITORIALS

Why Wait?

BUSINESS today is imbued with an air of hesitancy, a condition that is admittedly psychological in view of the markets to be met and the stocks to be replenished after the drain occasioned by the war. Nor can it be said that industry is not aware of the opportunities ahead, but it anpears to have adopted a sort of "watchful waiting" policy for prices to go down.

What, then, are the prospects of prices dropping?

Economists are agreed that there will not be any general fall in prices, and certainly not in the near future. Their conclusions are supported by the fact that the price of labor which enters so largely into every commodity has attained a new standard from which it is most certain not to recede. Moreover, history teaches that prices after all great wars have never returned to pre-war standards.

Here and there, where abnormal inflation exists, there will undoubtedly be some readjustment, but we must all face the fact that a new price level has been reached and that the value of the dollar has diminished.

The condition is not by any means local to this country; it is world-wide, and more pronounced the closer to the fighting area. In England, for instance, steel is much higher than in the United States, and the same is true of other commodities. Therefore, there is little to fear from foreign competition.

That most men fail to look beyond the relatively small sphere of their own business is only too true. Moreover, they lose sight of the fact that the greatest profits are usually made during periods of high prices.

But granting, in spite of all evidence to the contrary, that there might be a slight falling off in the next six months, the man who waits will be the loser. He is not only sacrificing the income and turnover on his investment during the interim, but is passing up opportunities to get in on the ground floor with the new business that is courting attention.

Therefore, why wait?

A General Engineering Society

THE nebulous idea, which has been acquiring density and consistency for some time past, of uniting the various branches of the engineering profession in an all-inclusive organization, is taking definite form. In the committees appointed by several of the societies to consider plans of reorganization which shall render the engineering societies of greater service to the community and the profession, the conception is growing of a federation composed of local and national engineering societies.

Local societies, unlike the professional national societies are generally all-inclusive. They invite to membership not only different kinds of professional engineers such as civil, mechanical, mining, electrical, chemical, metallurgical, etc., but also engineers of the nonprofessional class such as draftsmen, rodmen, operating engineers, sales engineers, etc. Thus they unite a large engineering group for the purpose of acquaintanceship and solidarity, for the hearing and discussion of engineering papers and lectures, and therefore they can bring to bear on local problems involving engineering features the organized engineering force of the community.

Such associations can act and in some cases are acting unitedly in matters of state or district interest by the appointment of joint committees upon occasion or the maintenance of permanent state or district associations.

The national general engineering society would take care of matters of general and national scope and would be composed of representatives from the local groups and from the professional and other national engineering societies. Local sections of the national professional societies may remain constituent parts of the local general engineering societies, as is now frequently the case, functioning as sections of their parent bodies in matters relating to these societies, but acting also, in matters of general local concern as individual units of the local general engineering society.

There would thus be built up a great democratic America-wide association uniting the engineering thought, talent and sentiment of the continent, organized for local and national activities, of which the existing specialized professional societies, national or otherwise, could become a part without losing their identity. The more the plan is studied the better it seems to meet the aims of those who aspire for a more universal organization of the engineers of America without arousing the apprehensions of the existing societies.

Industrial-Lighting Codes

Safety-First Measures

THE safety-first movement has been gradually manifesting itself in many forms during recent years, such as safety-first organizations in individual manufacturing plants, the "National Electric Safety Code" of the Bureau of Standards, state compensation acts and various codes for guarding the welfare of industrial workers. Among the latest additions to the number of state regulations for preventing injury to the health and limbs of employees in the industries are the lighting codes adopted by a number of states. As pointed out by G. H. Stickney in his paper, "Present Status of Industrial-Lighting Codes," presented before a joint meeting of the American Institute of Electrical Engineers and the Illuminating Engineering Society, held in New York City recently, "The industrial lighting codes are an expression of the safety-first movement in terms of legal regulations directed to the lighting of factories. The prime function of the codes is the safeguarding of life, limb and vision of industrial workers."

The fact that statistics show that twenty-three and eight-tenths per cent. of all industrial accidents are caused by insufficient or improper lighting should be all the argument necessary to establish the industrial

lighting codes as an expression of the safety-first movement, and to enlist the support of all managers and others in a position to see that proper illumination is installed in manufacturing establishments and power plants. Translating the above percentage into terms of economic waste it is equivalent to the loss of approximately one hundred and forty thousand employees per year of three hundred days. If only fifty per cent. of this loss in productive labor can be saved, a real economic advance will be made, to say nothing of the humanitarian considerations, which are of vastly more importance. In the introduction to the new edition of the Wisconsin Code, the necessity of such regulations are shown in the following statement: "Insufficient and improperly applied illumination is a prolific cause of industrial accidents. In the last few years numerous investigators, studying the causes of accidents, have found that the accident rate in plants with poor lighting is higher than in similar plants which are well illuminated. Factories that have installed approved lighting have experienced gratifying reductions in their accidents. To conserve the eyesight of the working class is a distinct economic gain to the state, but regardless of that, humanitarian considerations demand it." In addition to the foregoing advantage, production, it has been estimated, can be increased fifteen per cent. by the introduction of the proper illumination in our industries. Also the spoilage due to defective workmanship can be greatly reduced.

Poorly lighted passageways are prolific sources of accidents, and strange as it may seem, power plants are among the chief offenders in this respect. This comes about in general through insufficient illumination or none at all, or by allowing lamps and shades to become so dirty as to make them practically useless. On the other hand, lights so installed as to give intense glare are as bad as or worse than no light at all, and are also the cause of many accidents in places that are supposed to be illuminated. The prevention of injuries to body and health by better illumination marks another step in our industrial progress, and it will be well for all industrial-plant managers and power-plant engineers to have their plant illumination installed and maintained to conform to the best modern practice.

A Double-Barreled Investment

SOME misguided and ignorant folk have declared that they have no interest in the success of the Victory Loan campaign now under way. They insist that the war is over and that the need of war funds ended with the cessation of hostilities.

We wish that their statements were true and that as a consequence we might indorse their attitude. But the truth is that every citizen—yes, and every noncitizen—has a very vital interest in the floating of this final loan.

There are two arguments that should be brought to bear on the person who is able to subscribe to the present loan, but who is holding off because he feels no particular concern in it. Either one is sufficient to show how advantageous it will be for him to subscribe to the limit of his ability.

First of all, every one of us is eager for the return of prosperous times in business, but the prosperity of business is intimately bound up with the condition of the money market. If money is scarce and interest rates are high, credit is restricted and expansion of business is hampered. The result is stagnation and industrial depression. Therefore, the man who invests in Victory Notes, by mortgaging his future earnings, aids the banks in lending at reasonable rates and so hastens the return of those piping times of peace for which we are all yearning.

The second argument is an appeal of a purely selfish nature. The rate of interest on the new loan is higher than on any of the preceding ones and is therefore particularly attractive to small investors. It far exceeds the return to be obtained from savings banks, and the investment is so gilt-edged as to make ordinary stocks and bonds look like tarnished brass by comparison.

Subscriptions to the Victory Liberty Loan not only insure a high return in the matter of interest, but hasten the reëstablishment of business on a normal footing.

Killing two birds with one stone has always been considered an economical and thrifty performance. It is doubly commendable when applied to the purchase of Victory Notes.

In a memorable speech last week before the Seventh Annual Convention of the United States Chamber of Commerce, at St. Louis, Secretary Glass of the Treasury Department said: "The American people should supplement the patriotism of war by the patriotism of peace, and just as the American soldiers on the field battled to notable conquest for liberty, so American business men in different ways and through different instrumentalities should now give expression to their patriotism by promptly and cheerfully meeting the obligations of citizenship, the foremost obligation of which is to guard jealously the honor of the Nation; to regard its commitments as his own, and willingly contribute his labor and his substance for complete payment of our debt in the spirit of the National Prosperity Campaign, whose efforts for the stimulation of business and confidence have been spread broadcast throughout the country over the slogan of LET'S GO." This is ample evidence that the Government is heartily in support of the idea.

C. A. Graves in another column calls attention to the lack of measuring instruments in boiler rooms. Mr. Graves was engineer to the New York State Fuel Administrator and speaks from observation of a large number of cases. If engineers would impress their employers with the gains to be expected from the use of such apparatus and with their ability to handle it to advantage, there would be more of it in use.

Water-gage glasses frequently burst in the boiler room, and care should be taken to see that they are properly guarded. By the way, how many water-glass guards have you in your plant?

The fireman who will shovel sufficient coal into a furnace so as to permit him to sit down for half or three-quarters of an hour will never make a record with a CO_2 recorder.

Well-polished brightwork in an engine room is like the cherry in a cocktail—it doesn't have any noticeable influence on the action, but it certainly does add to the attractiveness.

Nitrogen in the air supplied to a boiler furnace must feel just about as useless as snowshoes on a Hottentot.

Correspondence

Noisy Compressor Valves

Recently, I had an experience with slamming air-compressor valves. The compressor delivers air at 15 lb. pressure, and "according to the oldest inhabitant" the valves had always been noisy. The seat was made at an angle of 45 deg. and is 3½ in. diameter. The outside diameter of the valve was 4 in., with 1-in. lift, and it

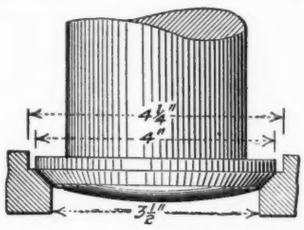


FIG. 1. LOW VALVE SEAT FROM REGRINDING

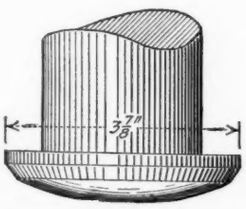


FIG. 2. NEW DIAMETER OF THE VALVE

was held to the seat by a spring made of steel 0.145 in. in diameter and 11 in. long, with 20 coils. It requires 18 lb. to compress it 6¼ in., the closed position of the valve.

Originally, the seats came flush with the surface of the valve deck, but repeated grinding and reseating had brought them about ⅜ in. below the surface, as shown in Fig. 1. Someone had bored the deck surrounding the seat to a diameter of 4¼ in. to provide space for the escape of the air, but it was not enough.

The inside diameter of the contact circle between the valve and the seat was 3½ in. and the outside diameter was 4 in., a difference in area of almost 3 square inches. With 15 lb. pressure per square inch in the cylinder and the same pressure on the discharge side of the valve, there would be an unbalanced pressure of a little more than 44 lb. plus the pressure of the spring, 18 lb., and a little due to the oil film on the seat.

To balance this, the pressure in the cylinder had to rise to about 21.5 lb. per sq.in. As soon as the valve lifted from the seat, on account of the restricted passage for the escape of the air this pressure would be exerted on the 4-in. diameter of the valve with the result that the valve would be thrown back against the stop, causing a slam, and when seating the heavy spring would cause a second slam.

To overcome the first slam I had a part of the valve face turned at an angle of 55 deg., leaving an annular contact circle about ⅛ in. wide, and the outside diameter of the valve turned down from 4 to 3⅞ in., giving more opening for the escape of the air (see Fig. 2). In order to relieve the second slam I changed the springs to weaker ones, making them 9 in. long with 18 coils, 0.125 in. steel, 2⅛ in. outside diameter, and requiring 6 lb. to compress to 6¼ inches.

After these changes were made, the piston began to strike the head, indicating that the clearance had been very slight and that less work was required to deliver the air.

R. McLAREN.

Toronto, Ont., Canada.

Factor of Safety of Repaired Flywheel

An old-fashioned box-bed gib-and-key type of plain slide-valve engine built about forty years ago is used for driving the muck rolls in a rolling mill, the 14-in. engine shaft being directly connected to the roll shaft. The cylinder dimensions of the engine are 24 x 48 in. and the speed is about 60 r.p.m. A throttling governor controls the speed.

The flywheel is 20 ft. in diameter and has a 9 x 12 -in. rim section. The rim is made in eight segments, each segment being cast integrally with a single spoke. The eight spokes are secured to the hub by clamping them between cheek-plates as indicated in Fig. 1. Each rim-joint is fastened with a bolt and with two wrought-iron links shrunk into recesses in the sides of the rim.

The engine and flywheel have been several times dismantled and reërected in a different location. In the course of one of those removals a clamping lug on one of the rim segments of the wheel was broken off as shown in Fig. 2. Fig. 3 shows how it was repaired.

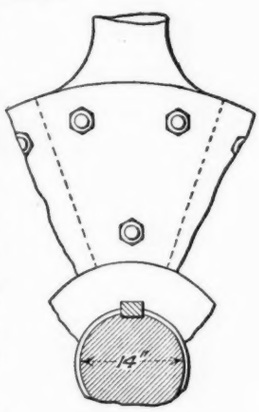


FIG. 1

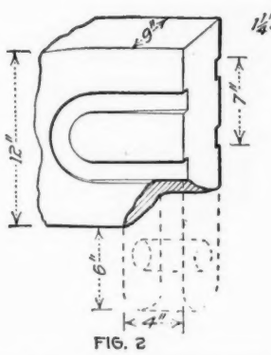


FIG. 2

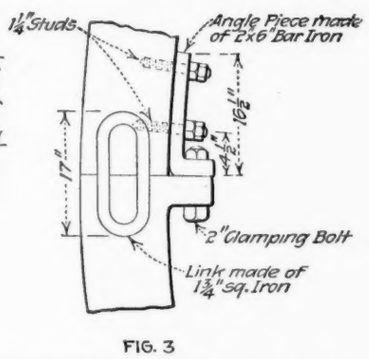


FIG. 3

FIGS. 1 TO 3. SHOWING METHOD OF REPAIRING BROKEN LUG ON FLYWHEEL
Fig. 1—Fastening of arm at hub. Fig. 2—Break in lug at rim. Fig. 3—Manner of repairing break

With a centrifugal pull of approximately 26,800 lb. on the rim joint, as is the case with the engine running at 60 r.p.m., the wheel is no doubt amply strong. However, since a patch fastened to anything broken must necessarily lack more or less the efficiency of the original unimpaired construction, it would be interesting to know just how much the factor of safety in this case has been diminished.

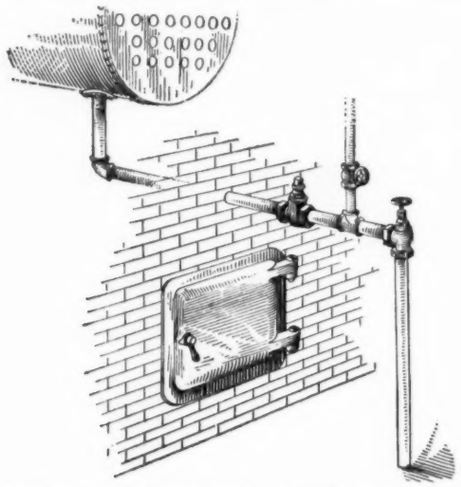
A. J. DIXON.

St. Louis, Mo.

Flushing Boiler Blowoff Valve

I have followed with interest the boiler blowoff discussion in *Power*. On page 818 of the Dec. 13, 1918, issue W. H. Wakeman says exactly what I want to say as regards both the location and the order of operation of the cock and valve, but I would like to add a feature that has given me splendid service.

As shown in the illustration, I inserted a tee between the cock and valve and to it connected a 1-in. line from



PIPING FOR FLUSHING BLOWOFF VALVES

the feed-water main. This serves me in three ways as follows: In the closing operation I close the cock first, then open the 1-in. line for a few seconds and wash the valve faces clean of all sediment before closing it. This keeps the valve faces tight almost indefinitely. When the valve does need either regrinding or a new disk, the operation can be performed in comfort by letting a little cold water in through the 1-in. line to condense and cool any leakage passing the cock.

If sediment and scale are allowed to settle in the vertical blowoff line until it will not move out with the boiler pressure, the cock can be opened and the pump pressure raised through the top line and the sediment forced upward into the boiler and blown out.

Vancouver, B. C., Canada. R. MANLY ORR.

Feed-Water Check-Valve Failure

A short time ago I was called out to a small power station to look over a tubular boiler that had been reported damaged by low water, and on arriving at the plant found that the boiler had been drained and cooled off to allow an examination by the boiler inspector. After a careful examination of the shell and tubes, he reported that the back head bulged about ¾ in. and had pulled away from several tubes; also that the two top rows of tubes and the tube sheet had been burned badly. His immediate opinion of the cause was low water caused by a careless fireman. After hearing his report and listening to the description of the accident by the chief engineer, the writer asked the engineer to get a wrench and take the cap off the boiler-feed check. When this valve was opened, a piece of duck packing from the water cylinder of the feed pump was found wedged under the check so that it could not close.

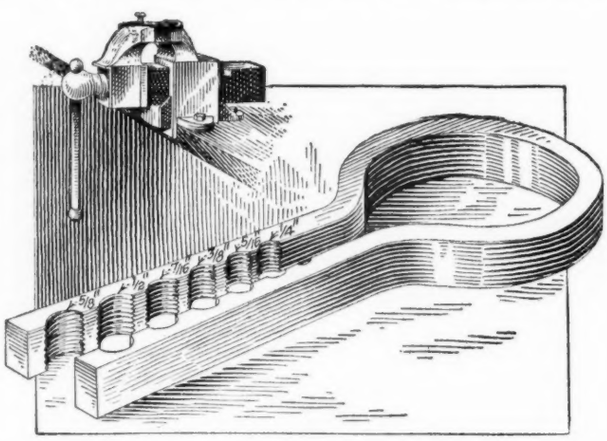
Here is what happened: The engineer had been out of the fireroom about twenty minutes and had just returned when the fireman said he could not hold water in the boiler, although the feed line was wide open. There were three other boilers on the same header taking water from the same pump. The water dropped out of the glass so quickly that it was necessary to pull the fire. The boiler started to leak badly on the top row of tubes. The automatic stop valve closed and cut the boiler off the line. The faster the fireman ran his pump the faster his water fell in the gage-glass. The water rose in the other boilers, due to siphoning action from the damaged one.

If the fireman had closed the feed valves on the other three boilers, or the one on the defective boiler, when the water was going out of the glass, and then pulled the fire, the boiler would have been saved from damage. Sometimes these accidents happen so quickly that the average fireman does not have time to think over all the combinations that can happen. In my 28 years of power-station experience this is the second time I have seen an accident of this kind from the same cause and with the same result. R. J. FOX.

Chicago, Ill.

Simple Machine-Screw Holder

The illustration shows a simple tool to hold machine screws by placing them in the threaded holes and then securing the tool in a vise so as to hold it firmly and still not damage the threads of the screws. The tool is made as follows: First a piece of cold-rolled key stock is bent in the manner shown, after which the ends



SCREW CLAMP AND ITS APPLICATION

are placed in a vise with a piece of fuse strip to give clamping room between them. Holes are then drilled and tapped in graduated standard sizes, or any other sizes required, and the tool is case-hardened to prevent damage from filing and sawing. VAUGHAN LADD.

Lima, Ohio.

Removing Burnt Oil

Burnt oil can be easily removed from the polished work around the cylinders of engines, etc., by using Bon Ami and rubbing the oily spots with a wet cloth, applying it to such parts while they are hot. It is remarkable how it removes the oil without scratching the polished surfaces. JAMES C. BROWNING.

Joliet, Ill.

Lack of Power Plant Meters

It is remarkable what a large number of power plants have no means of measuring the water or coal used and therefore can make no comparison of their operation from day to day with standard practice. Even comparatively modern plants of several hundred horsepower have only the usual equipment of steam and water gages.

Although I am not interested in the sale of boilers or of accessories, it seems to me that this condition is largely due to the policy of the boiler manufacturer to sell only boilers. The electric generator manufacturer in many instances, when a generator sale is made, sells all the meters, etc., that can be used. Many accessories are also sold with automobiles.

Purchasers of boilers, however, unless they have competent engineering advice, will not usually consider the installation, with the boiler, of steam or water meters, or soot blowers, or draft gages, because these are classed as extras and entail an additional cost.

If the boiler salesman, in quoting on an installation, would include the desirable meters and accessories, the purchaser would obtain an equipment that would be of the greatest benefit to him.

This seems to be the appropriate time for the boiler men and the accessory men to get together to the advantage of both, with probably the greater advantage to the boiler manufacturer, as complaints on the operation of particular installations can be readily satisfied without the expense of elaborate tests if proper accessories are installed. It is unnecessary to mention the benefit the purchaser would derive from such getting together.

C. A. GRAVES.

New York City.

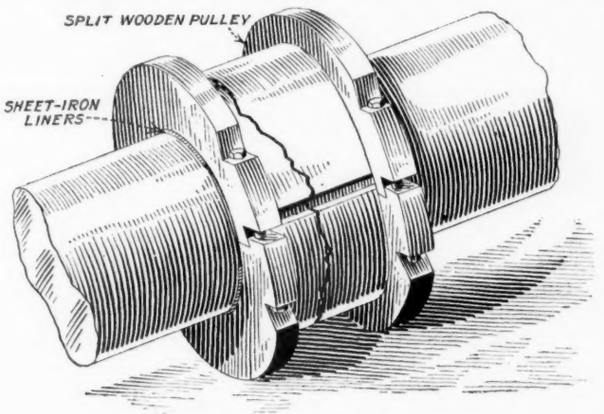
Flywheel Explosion in St. Louis

In the report, published in the Feb. 4 issue of *Power*, page 186, of a flywheel explosion in a rolling mill, it was stated that the accident could be traced to no definite cause. This was true at the time, inasmuch as those in a position to explain the exact cause disclaimed all knowledge of it. Precise information on this point has, however, since come to light.

Measurements taken of a segment of the rim that landed in the third story of a neighboring manufacturing plant showed the wheel to have been 9 ft. diameter, with an 8 x 6½-in. rim section. The wheel was in halves, which were held together at the rim with 1¼-in. clamping bolts, reinforced by 1-in. oval links shrunk in recesses in the sides of the rim. According to the statement of a man long familiar with conditions in the mill, one of the spokes was cracked through at the hub, the result, no doubt, of rough handling in one of the several dismantling and reassemblings that marked the early history of the engine.

The engine was belted to a lineshaft from which the blast fans were driven. Its cylinder dimensions were 14 x 28 in. and the speed 120 r.p.m. As originally built it was of the automatic cutoff type, with flat valves. Some years ago, however, the automatic features were removed, and with the addition of a throttling governor the engine was converted to the old-fashioned plain slide-valve type. From the statements of men acquainted with the history of these details, it appears that when the change was made, the question of providing a main-shaft pulley for driving the governor belt was answered by pressing into service a discarded wooden split pulley that happened to be of about the right diameter and width. The bore of this pulley was found to be somewhat large for the shaft, but that defect was remedied by lining out the bore with sheet iron. The pulley was made with flanges for holding on the belt and was clamped to the shaft with four $\frac{5}{16}$-in. bolts, as shown in the sketch herewith.

In the course of time cracks appeared in the face of the pulley, and these eventually extended through both halves, as indicated in the sketch. The two ends of the pulley thus developed a tendency to part company in the middle and work along the shaft in opposite directions. To prevent this the ends were bound together with wires wrapped around the clamping bolts. But as it was difficult to draw the wires perfectly taut, this mode of fastening continued to give trouble until someone hit upon the happy idea of wrapping a piece of tin around the pulley and securing it with tacks. One day the oily rubbish that had accumulated in the flywheel pit caught fire from sparks thrown from the rolls, and the flames lapping up around the governor pulley left



HOW THE GOVERNOR BELT SPLIT

it badly charred and disfigured and certainly did not improve its holding quality.

As may readily be surmised, this pulley early manifested a tendency to slip on the shaft and so permit the engine to speed up. Whenever this would occur, the bolts would be tightened and perhaps the old liners would be taken out of the bore and new ones with a rougher and more biting surface would be put in their place. One man who had handled the engine for a number of years stated that he found by experiment just how much to open the throttle to keep the governor balls hovering at the point of rising to a running plane with the maximum pressure carried in the boilers. Having the throttle so adjusted, he would secure it by wiring a heavy weight to the handwheel. Another man who had handled the engine for a considerable period, but who had not adopted the precaution just mentioned, states that on several occasions he barely managed to reach the throttle in time to avert disaster.

The bursting of the flywheel was unquestionably due to overspeed caused by the governor becoming inoperative on account of its driving pulley slipping on the main shaft.

Two segments of the exploded rim did considerable damage to manufacturing plants located on opposite sides of the mill—one north and the other south. One

of the segments, weighing 407 lb., cut though a 9 x 9-in. wooden truss-beam in its flight through the mill and broke through the roof of a three-story boiler house 600 ft. distant. The angle of elevation of this fragment as it shot out from the disrupted wheel and the parabola which it described in its descent were determined and a trajectory made. Figured on the data given, the rim speed at the instant of disruption was 173 ft. per sec., corresponding to 368 revolutions per minute.

Taking into account the retarding effect of obstacles encountered in its flight through the mill, it is probable that this fragment was projected with a higher initial velocity than the figures show. This view is substantiated by the obvious intensity of the force with which a 1082-lb. segment hit the third-story brick wall of the manufacturing plant standing to the north. A mass of heavy steel structural work was piled against the inner face of the wall. The flying fragment ploughed through this barrier and brought up against the massive steel frame of a riveting machine about thirty feet distant, the final impact further shattering the fragment into three pieces.

Fortunately, the accident happened on a Saturday afternoon, shortly after the employees in the last-mentioned plant had quit work. Had it occurred an hour earlier, it probably would have resulted in death or injury to several. A. J. DIXON.

St. Louis, Mo.

Eliminating Cylinder Oil from Exhaust Steam

From reading the article entitled "Eliminating Cylinder Oil from Exhaust Steam," by W. H. Wakeman, in *Power* of Mar. 11, page 365, it is evident that the matter was handled by rule of thumb without any definite idea as to what was happening in the separator or as to what caused the trouble. This question can be analyzed as follows:

Take this 300-hp. engine with 30 lb. of steam per horsepower-hour. Assuming the steam at 2 lb. back pressure, we have a specific volume of the steam of 23.8 cu.ft. The area of the 8-in. separator is 50.266 sq.in., or 0.349 sq.ft. The velocity of steam through the separator per minute will then be $\left(\frac{300 \times 30 \times 23.8}{60}\right) \div 0.349 = 10{,}229$ ft. per min. When the change was made to a 12-in. separator the area was increased from 0.349 sq.ft. to 0.785 sq.ft., thereby decreasing the velocity of steam per minute to $\left(\frac{300 \times 30 \times 23.8}{60}\right) \div 0.785 = 4548$ feet.

It is well known that the separation of oil from steam cannot be done unless there is a quantity of water present in the steam. The water acts as a carrier in removing the oil. Each drop carries a thin film of oil on the outside. With the velocity of 10,229 ft. per min. through the 8-in. separator, this water carrying the oil would strike the baffle plates with such a tremendous force that it would be shattered into an exceedingly fine mist, would rebound from the surface, would be picked up by the flow of steam and would be carried around the baffle.

By changing to a 12-in. separator the velocity was decreased to practically 4548 ft. per min. At this speed, the impact on the baffle would not be great enough to disintegrate the oil and water into a fine spray, and the blanketing effect of the steam would not be overcome to such an extent but that the water would run down the baffle to the storage well below and separation would take place.

My experience, covering several hundred installations of similar character, indicates clearly that the wrong type of separator was installed to handle this work. An 8-in. separator of the centrifugal type properly designed would have made the conditions as outlined in the article impossible and would have given better separation than was obtained with the 12-in. separator of the other type. This would have resulted in a saving of 40 to 50 per cent. in purchasing a separator, not to mention the extra expense of installing the 12-in. connections. R. J. PABODIE.

Chicago, Ill.

It is probable that Mr. Wakeman's trouble could have been eliminated in a much cheaper way by installing a separator of different design. While an allowance of 90 lb. per sq. in. per hour may be correct for the single-baffle type of separator, the multiple-baffle type has shown itself to have a much larger capacity. This type usually has baffles that have a comparatively large area relative to the exhaust-pipe area, and consequently the steam has a much lower velocity over the baffles than in the case of the single-baffle type.

The allowance of 90 lb. per sq.in. per hour is considerably less than is usually found in ordinary plants. A 50-hp. horizontal engine would have about a 4-in. exhaust connection. Assuming a steam consumption of 35 lb. per hour, the flow of steam through the pipe would be at the rate of about 139 lb. per sq.in. sectional area per hour. As many separators are giving good service under approximately these conditions, it would seem that the 90 lb. allowance is rather low—for the smaller sizes at any rate. D. F. GRAHAME.

Ottawa, Ont., Canada.

Avoiding Unnecessary Pumping

W. T. Meinzer, in his article, "Avoid Unnecessary Pumping," page 220 of the Feb. 11 issue, doubtless unintentionally forgot to mention one point. In most cities the water pressure will vary. It will be boosted up to around eighty pounds in case of fire and in up-to-date cities is raised for a short while during the night for testing purposes.

Under such a condition, with plunger pumps, a pounding would probably be caused, but it could be easily overcome by throttling the suction. In the case of centrifugal pumps, especially when driven by direct-current motors, the case is different.

Unless otherwise specified, the majority of manufacturers ship their pumps equipped with motors that are figured to be large enough to do the work required of them, provided the pumps take from a suction tank having a maximum head and no more. Coupling the city-water main direct to such a pump would greatly increase the pump's capacity, causing the motor to be overloaded, and sooner or later create an electrical breakdown that would be annoying to say the least.

Winnipeg, Man., Canada. O. PETTERSSON.

If Old Glory means anything to you, buy Victory Liberty Loan Notes.

Inquiries of General Interest

Current at Unity Power Factor—When a 1500-kw. 600-volt, three-phase alternator is operating at full load and unity power factor, what should each ammeter read if the load is balanced? E. M. C.

The reading of each ammeter should be the same and is equal to the kilowatt rating of the machine times 1000, divided by 1.732 times the volts, which in this problem is $(1500 \times 1000) \div (1.732 \times 600) = 1443$ amperes.

2200-Volt Motor on 440 Volts—What horsepower would a three-phase 50-hp. 2200-volt 750-r.p.m. motor develop if connected on a 440-volt line? P. F. M.

Theoretically, one-fifth of 50, or 10, hp. and the starting torque would be 1/25 of that at 2200 volts. The only thing to do is to reconnect the stator winding for 440 volts. Just what the grouping should be cannot be determined without knowing the number of coils and how they are grouped in the 2200-volt winding. If the 2200-volt winding is connected in series star, which is probably the case, then the 440-volt winding may be connected 5-parallel star. However, if the number of coils per phase cannot be divided by 5 it may be somewhat of a problem to distribute the coils so as to get a satisfactory winding. A 3-parallel delta connection might be found to give a more satisfactory grouping. This gives an equivalent 418-volt winding, which is close enough to 440 volts to operate satisfactorily.

Short-Circuited Wound Rotor—We have a 150-hp. 2200-volt three-phase 25-cycle motor. The rotor is wound and is rated at 263 volts and 245 amperes. Would it be possible to short-circuit the rotor leads and start the motor under about one-half rated load, with a compensation? P. F. M.

With the slip rings short-circuited the rotor may develop considerable starting torque if the winding has a comparatively high resistance. However, at best it is liable to develop locking points and, if the resistance of the rotor's winding is low, may give trouble to start a load requiring only a small starting torque. If it is necessary to use a compensator to start the motor with, instead of a resistance in the rotor circuit, better results could be obtained by short-circuiting the rotor conductors on rings at each end of the core, thus converting the machine into one of the squirrel-cage type. However, at best this is only a makeshift and is liable to give trouble. If satisfactory operation is to be expected of a motor of this size and voltage, it should be started in the way it was designed to be; namely, with an external rotor resistance.

Raising the Pressure of a Heating Boiler Without Increasing Its Capacity—A low-pressure steam-heating plant, operated with 15-lb. boiler pressure, is equipped with two boilers capable of carrying 100-lb. pressure, and during most of the heating season one boiler is sufficient. Could not the capacity be materially increased by generating the steam at 30- to 40-lb. pressure and supplying the system with the steam reduced to a pressure of 15 lb. per sq.in., by means of a pressure-reducing valve? A. J. C.

The heating capacity of a boiler depends on the amount of heat liberated by combustion of the fuel and received by the boiler. The same forcing of the boiler could result in liberation of only the same amount of heat, and by carrying a higher boiler pressure, the temperature of the boiler water and of the heating surfaces would be higher, and from that cause there would, if anything, be transfer of less heat of the fire. Hence the heating capacity could not be increased by raising the boiler pressure. Operation of the apparatus as a gravity return system at 15-lb. pressure and higher pressure on the boiler would necessitate the expenditure of steam or power for operating a pump or some other form of boiler feeder.

Resetting Valves to Change from Condensing to Noncondensing—What changes should be made in the valve setting of a Corliss engine if a change is made from running condensing to noncondensing? A. H.

When running noncondensing the exhaust will be at higher pressure, and for smooth running of the engine the necessary cushioning on the exhaust can be obtained by less compression, obtained by closing the exhaust valves later in the stroke. On a single-eccentric engine, set the eccentric back on the shaft so that only the necessary compression of exhaust is obtained, and see that the exhaust-valve rods are short enough to obtain release before the end of the expansion stroke. Setting the eccentric backward will delay admission and the steam-valve rods will need to be shortened so the valves will have less lap and proper lead. With the wristplate hooked in gear, place the engine first on one center and then on the other and adjust the valve rods to suitable lengths for obtaining the proper lead and release. With a double-eccentric engine, setting of the steam eccentric and steam-valve gear needs to be no different than when running condensing, and for less compression of the exhaust, the exhaust eccentric and exhaust-valve gear would require the same attention as the valve gear of a single-eccentric engine, but omitting all consideration of the steam valves and their rods.

Cylinder Clearance of Air Pump—What is the greatest percentage of cylinder clearance permissible for an air pump to obtain 29¾ in. vacuum? J. C. A.

When referred to the standard atmospheric pressure of 30 in. of mercury column pressure, 29¾ in. vacuum would be equal to an absolute pressure of $30 - 29.75 = 0.25$ in. of mercury-column pressure. At a constant temperature the volume of a given weight of air is inversely as its absolute pressure. Calling the piston displacement of the air pump D and the clearance percentage c, when 29.75 in. vacuum is attained at the end of a suction stroke, the volume of air contained in the cylinder and clearance space would be $D(1 + c)$. During the return stroke the air cannot be discharged until it has been compressed to the pressure of the atmosphere or an absolute pressure of 30 in. of mercury column. Calling the volume at atmospheric pressure v, then as

$$v : D(1 + c) :: 0.25 : 30,$$
$$30v = 0.25D(1 + c) = 0.25D + 0.25Dc$$

from which

$$v = \frac{0.25D + 0.25Dc}{30}$$

If $v = Dc$, then by substitution

$$Dc = \frac{0.25D + 0.25Dc}{30}$$

from which $c = 0.0084$.

But when $v = Dc$ no discharge can take place, for if the air has not been compressed a little above atmospheric pressure before the volume is compressed to the clearance volume Dc (that is, before the piston reaches the end of the stroke), it cannot be discharged against the pressure of the atmosphere. For the condition the air would be compressed into the clearance space at or slightly above the pressure of the atmosphere and, during the succeeding suction stroke, no more air at 29.75 in. vacuum could be drawn into the cylinder, for the clearance air could not reëxpand to a lower pressure than it had at the beginning of the compression stroke. Hence, barely nominal capacity would be obtainable for 29.75 in. vacuum with the clearance more than $\frac{84}{100}$ of 1 per cent., and for any degree of vacuum the larger the free air capacity the smaller the percentage of clearance required.

Aims and Organization Committee of the Mechanical Engineers

Some thirty members of the Committee on Aims and Organization of the American Society of Mechanical Engineers met at Galen Hall, Wernersville, Penn., on Thursday, Friday and Saturday, Apr. 24-26, to consider methods for broadening the scope of the society's activities, improving its efficiency and increasing the service which it can render to the community.

It would be premature to discuss in detail, before their submission to the Council, the various measures proposed for the purpose of improving the relations of the engineer to his work, to the community and to other engineers. The spirit manifested was progressive, and the recommendations of the various subcommittees such as, if adopted, to relieve the society of any shadow of opportunity for the application of criticism to which the national professional societies in general have been subjected on the ground of old-fogyism, inertia and self-satisfied complacency. The results of the three-days' discussion will be reduced to concrete form and presented for discussion at the spring meeting at Detroit.

N. E. L. A. Will Meet at Atlantic City

The National Electric Light Association will hold its 42nd convention in Atlantic City, May 19-22. On Tuesday morning, May 20, the first general and executive session will be held. The proceedings will be opened by an address of welcome to the city by Mayor Harry Bacharach, followed by an address by the president of the association, W. F. Wells, of the Brooklyn Edison Co., Inc. Reports as follows will then be given: Report of the acting secretary, S. A. Sewall; report of the Rate-Research Committee, by Chairman Alex Dow; progress report of Special Joint Committee on "Determination of Power Factor in Polyphase Unbalanced Circuits," by Chairman R. J. McClelland. In the evening the second general and executive session—The Public-Policy Session—will be held, at which the following reports and address will be made: Report of Public-Policy Committee, by Chairman W. W. Freeman; report of the National Committee on Gas and Electric Service, by Chairman J. W. Lieb; address on "The Trend of Socialism," by F. G. R. Gordon.

The Accounting Section will hold its first session on Tuesday afternoon and its second session on Wednesday afternoon. The Commercial Section will hold its first session on Tuesday afternoon; its second, third and fourth sessions on Wednesday afternoon and its fifth on Thursday. Among the many reports, discussions and papers at these sessions will be the following: At the third commercial session there will be a discussion on the "Effect of the War on Isolated Plant Costs," led by I. Lundgaard; "Digest 1917 Report of Electrical Heating Bureau — Electrical Heating of Nonferrous Metals," by C. F. Hirshfeld; and a paper on "Power Factor in Customers' Installations," with discussion led by R. H. Knowlton. At the fourth commercial session there will be discussion on "Electric Welding," led by F. E. Richards. The Electric Vehicle Section will hold its first session on Tuesday afternoon and its second on Wednesday afternoon. The Technical and Hydro-Electric Section will hold its first and second sessions on Tuesday afternoon and its third on Wednesday. The first session will be opened with an address by the section chairman, R. J. McClelland, followed by a report of the Committee on Prime Movers, by Chairman N. A. Carle. The second technical session will open with a report of the Committee on Underground Construction and Electrolysis, by Chairman E. B. Meyer, followed by a report of the Committee on Overhead Lines and Inductive Interference, by Chairman A. E. Silver. The third technical session will open with a report of the Committee on Electrical Apparatus, by Chairman R. F. Schuchardt, followed by a report of the Committee on Meters, by Chairman F. V. Magalhaes.

The third general and executive session will be held on Wednesday morning and among various reports will be an address on "Regional Power Systems," by George Otis Smith. The fourth general and executive session will meet on Thursday morning, opening with a report of Committee on Safety Rules and Accident Prevention, by Chairman William C. L. Eglin. This will be followed by various other reports.

William T. Wheeler

William T. Wheeler, president of the Diamond Carbonating Co., Inc., New York City, died suddenly at his home in Brooklyn, of acute indigestion on Apr. 26. Mr. Wheeler

WILLIAM T. WHEELER

was born in Calais, Me., 52 years ago. He was for some years connected with the Trinity Engineering Co., later first assistant engineer of the Equitable Life Insurance Co. and chief engineer of the New York Life Insurance Co. He was a well-known construction engineer and was very popular. He was a past president of the National Association of Stationary Engineers and was also a member of the American Society of Mechanical Engineers. He was a member of the Jamaica Bay Yacht Club, Brooklyn Lodge of Elks, No. 22, Scottish Rite, past master of Joppa Lodge, No. 201, of Brooklyn, a former commander of Damascus Commandery, a member of the Kismet Temple, Nobles of the Mystic Shrine, and was formerly grand steward of the Masonic Grand Lodge of the State of New York.

Personals

T. J. Hudson, of the Chicago Pneumatic Tool Co. has been appointed acting manager of the Pneumatic Tool Sales Division, to succeed F. H. Waldron, who returns to Minneapolis, Minn., as district manager of sales for the Minneapolis territory.

F. W. Fischer, who has been assistant power superintendent of Du Pont Engineering Co., at Wilmington, Del., has been appointed mechanical superintendent in charge of the power, electric and maintenance divisions of Old Hickory Powder plant at Nashville, Tenn. Mr. Fischer was formerly assistant master mechanic of the Muscle Shoals plant in Alabama.

Obituary

William F. McDonald, president of the Wm. F. McDonald Co., Detroit, Mich., died suddenly at his home in same city on Apr. 25. Mr. McDonald was secretary of the Michigan Chapter of the American Society of Heating and Ventilating Engineers, chairman of the Committee on Increase of Membership, and member of the Committee on Research, and his loss by the Society will be keenly felt. He was 42 years of age.

Engineering Affairs

Kansas State Association, N. A. S. E., will hold its convention at Topeka, May 7-9.

The New York Chapter of the American Association of Engineers met at the United Societies Building, Wednesday, Apr. 23. The principal speaker was Robert M. MacBride, a publisher and journalist, who went to Europe with the party of journalists, and visited the battlefields of France and occupied Germany. The next meeting will be held May 14, when the newly elected officers will be installed.

The Chicago Sections of the American Institute of Electrical Engineers and the Association of Iron and Steel Electrical Engineers will hold a joint meeting on May 26, at which J. C. Wilson, assistant chief engineer of the Cutler-Hammer Manufacturing Co., will give a lecture on "Measuring Gas Electrically," and B. E. Fernow, of the same company, will lecture on "Lifting Magnet Operation." Both lectures will be illustrated.

Massasoit Association No. 2, N. A. S. E., of Springfield, Mass., held its annual banquet at the Highland Hotel, on Saturday, Apr. 26. The main hall was filled to capacity, and tables were set in an adjoining room to accommodate the overflow. The speakers included F. R. Low, of "Power"; Walter H. Damon, George Madsen, Claude Allen, of Garlock Packing Co.; Harry Mantham, W. J. Reynolds, J. H. Henderson and others. The entertainment was furnished by the Ladies Des Rosierses Trio; L. H. Serre, of Jenkins Bros.; Bob Jones, of the France Metallic Packing Co., and Jack Armour, of "Power." Herbert E. Stone was the toastmaster.

The Iowa National Association of Stationary Engineers will hold its annual state convention at Marshalltown, Iowa, June 11-13. The following papers and talks will be given at the convention: Lantern talk on "The Uniflow Engine"; movie talk on "Iron from the Mine to the Tube"; talks on "Flow Meters"; "Isolated Plants"; "James Watt"; "Development of the Steam Gage"; "Plant Operating Economies." Arrangements have been made for visits to many large plants. There will be a banquet on the evening of the closing day at the Pilgrim Hotel, the headquarters of the convention, at which Prof. W. H. Meeker, of the Iowa State College, will be the principal speaker.

The American Society of Mechanical Engineers will hold its spring meeting in Detroit, June 16-19, with headquarters at the Hotel Statler. The tentative program is as follows: Monday, June 16: Registration in forenoon; business meeting in afternoon; followed by a general meeting at which the Committee on Aims and Organization will make a report; informal reception at the hotel in the evening. Tuesday: Research session in the morning and Industrial Relations session in the afternoon; social in the evening. Wednesday: Morning session in charge of Detroit Local Committee and a Miscellaneous session; afternoon and evening, boat trip and dinner on the Lake. Thursday: Gas Power and Miscellaneous sessions in the morning; excursions in the afternoon.

The American Association of Engineers will hold its annual meeting at the Hotel La Salle, Chicago, May 12-13. The first morning will be devoted to registration and reports of officers and standing committees, followed by a discussion on the "Relation of Other Societies to the American Association of Engineers" and "The Relation of Engineers to Each Other in Employment." In the afternoon Prof. F. Bass, of the University of Minnesota, will talk on "How the Curricula of Engineering Colleges Shall Be Modified to Meet Modern Conditions." On May 13 the following papers will be presented at the morning session: "Proper Compensation of Engineers—Ways and Means of Obtaining It—Recognition Through Self-Improvement and Service"; "The Engineer in Politics"; "Action on Behalf of the Engineers in Public Service." In the afternoon the discussion will be on "Employment and Opportunities," followed by business session, dinner and social to finish.

Business Items

The Bowers Rubber Works, San Francisco, Calif., has changed the name of the company to the Pioneer Rubber Mills.

The Chicago Pneumatic Tool Co. announces the election of Allan E. Goodhue as managing director if its English subsidiary, the Consolidated Pneumatic Tool Co., Ltd., whose offices are at 170 Piccadilly, London, and whose plant is in Fraserburg, Scotland. Mr. Goodhue will also be in charge of European sales for the Chicago Pneumatic Tool Co. He was for a number of years connected with the sales department of the Midvale Steel Co. and Midvale Steel and Ordnance Co. in Philadelphia, Chicago and Boston, leaving that company in March, 1918, to enter the service of the Government as assistant manager of the Steel and Raw Material Section, Production Division, of the Emergency Fleet Corporation.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.15@2.75	$2.80@3.35
Philadelphia, gross tons	4.20@4.90	5.00@5.40
New York, gross tons	4.50@5.25	5.35@5.80
Alongside Boston (water coal), gross tons	6.10@6.85	6.90@7.65

Pocahontas and New River are quoted at $4.70@5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$5.95	$7.80	Pea	4.80	6.55
Egg	5.85	7.70	Buckwheat	3.40	5.15
Stove	6.10	7.95	Rice	2.75	4.50
Chestnut	6.20	8.05	Barley	2.25	4.00

Bituminous

	Spot	Contract
South Forks	$2.90 @ $3.25	$2.95 @ $3.50
Cambria County (good grades)	2.80 @ 3.10	2.95 @ 3.25
Clearfield County	2.65 @ 2.95	.....
Reynoldsville	2.65 @ 2.85	2.85 @ 2.95
Quemahoning	2.75 @ 2.95	2.95 @ 3.10
Somerset County (best grades)	2.75 @ 2.95	2.95 @ 3.10
Somerset County (poorer grades)	2.25 @ 2.50	2.50 @ 2.75
Western Maryland	2.25 @ 2.75	2.50 @ 2.75
Fairmont	2.10 @ 2.35	2.35 @ 2.50
Latrobe	2.10 @ 2.25	.....
Greensburg	2.35 @ 2.40	2.35 @ 2.60
Westmoreland	2.60 @ 2.75	2.65 @ 2.75
Westmoreland run-of-mine	2.40 @ 2.65	2.40 @ 2.65

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	5.85	7.70	Rice	2.75	3.65
Stove	6.10	7.95	Boiler	2.50	3.50
Nut	6.20	8.05	Barley	2.25	3.15
Pea	4.80	6.40	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@2.50	3.00
Screenings	1.85@2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	.....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.85@$4.50
Corona	3.40
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County		Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	.....	.....
Williamson County			
Prepared sizes, lump, egg, nut	$2.55	$2.55	$1.90@2.25
Mine-run	2.35	2.20	2.00
Screenings	2.20	2.05	1.75
3-in. lump	.....	2.30	.....
2-in. lump	.....	.....	2.15

Williamson-Franklin rate to St. Louis is $1.07½; other rates 92½c.

New Construction

PROPOSED WORK

Conn., Naugatuck—The Y. M. C. A. Rockwell Ave., will install a steam heating plant in the 3-story building which it plans to build on Church St. Total estimated cost, $175,000. L. W. Jallade, 37 Liberty St., New York City, Arch.

Conn., Waterbury—The Board of Education plans to install a steam heating plant in the addition which it plans to build to Croft St. School. Total estimated cost, $125,000. L. A. Walsh, 50 Leavenworth St., Arch.

N. Y., Amsterdam—The Adirondack Electric Power Corp., 30 East Main St., plans to build a transmission line from here to Little Falls. C. O. Wilson, Supt.

N. Y., Brooklyn—The Brooklyn Hebrew Home & Hospital for the Aged, Howard and Dumont Aves., will install a steam heating plant in the 4-story, 90 x 100 ft. home and hospital addition which it plans to build. Total estimated cost, $100,000. L. A. Abramson, 220 5th Ave., New York City, Arch.

N. Y., Brooklyn—The Cairns Holding Co. Inc., c/o the Gillies Campbell Co., Contractors, 101 Park Ave., New York City, will install a steam heating system in the 9-story, 75 x 119 ft. factory which it plans to build on Atlantic Ave. and Classon St.

N. Y., Brooklyn—The Levy Bros., 189 Montague St., will install a steam heating plant in the 2-story, 130 x 180 ft. theater which they plan to build on Bedford Ave. and Lincoln Rd. Total estimated cost, $500,000.

N. Y., Brooklyn—The Washington Amusement Co., c/o Zipkes, Wolff & Kudroff, Arch., 25 West 42nd St., New York City, will install a steam heating plant in the 1½-story, 100 x 137 ft. theater which it plans to build on Washington Ave. and Prospect Pl. Total estimated cost, $100,000.

N. Y., Cohoes—The Board of Education will install a steam heating plant in the 3-story high school which it plans to build. Total estimated cost, $210,000. Tooker & Marsh, 101 Park Ave., New York City, Engr.

N. Y., Far Rockaway—B. S. Moss, 729 7th Ave., New York City, will install a steam heating plant in the theater which he plans to build on Mott Ave. and St. James St. Total estimated cost, $250,000. De Rosa & Pereira, 110 West 40th St., New York City, Arch.

N. Y., Geneseo—L. F. Pilcher, State Arch., will soon receive bids for remodeling and building an addition to the heating and ventilating systems at the Geneseo Normal School here. $60,000 available for the project. Address J. V. Sturges, Principal.

N. Y., Glen Falls—The Arrow Grip Manufacturing Co. has increased its capital stock from $100,000 to $500,000 and will install power, heating and special machinery in the factory which it plans to build on land adjoining the Delaware & Hudson R. R. Total estimated cost, $150,000.

N. Y., Iroquois—The Board of Managers, Thomas Indian School, plans to install refrigeration equipment for the ice house, also dairy room and cold storage building and ammonia system. W. Hunt, Pres.

N. Y., Long Island City—The Louraine Magneto Co., Bridge Plaza, has awarded the contract for the construction of a 3-story, 100 x 150 ft. factory on 13th St., near Van Alst Ave., to the Northeastern Supply Co., Harris Ave. A steam heating system will be installed in same. Total estimated cost, $125,000.

N. Y., New York—The Terminal Warehouse Co., 17 South William St., will install a steam heating plant in the 2-story warehouse which it plans to build at 29-31 South William St. Total estimated cost, $100,000. J. W. O'Connor, 3 West 29th St., Engr.

N. Y., Rochester—The Whit-Field Map Co. Inc. will install power and special machinery in the factory which it plans to build. Estimated cost of machinery and power from $25,000 to $35,000. Address I. A. Whitman, Rochester.

N. Y., Watertown—The Northern New York Utilities Co. Inc., Light & Power Bldg., plans to build a transmission line from Watertown to Brownville and replace the present 3,000 volt current with one of 22,000 volts. Electrical equipment, including transformers, etc., will be required for same. H. G. Davis, Ch. Engr.

Penn., Tamaqua—J. G. Mealey, Tamaqua, and J. L. Goadle, Palmerton, have leased from the Lehigh Coal & Navigation Co. the group on which they plan to build a 2-story, 67 x 90 ft. factory for making ice and ice cream. Estimated cost, $100,000.

D. C., Washington—The George Washington Memorial Association, Scott Circle, will install a steam heating plant in the 4-story, 200 x 220 ft. memorial building which it plans to build. Total estimated cost, $4,000,000. Tracey & Swartout, 18 West 34th St., New York City, Engr.

Ga., Columbus—The Eagle & Phenix Mills, Front St., plans to build a new power house. Lockwood, Greene & Co., Healey Bldg., Atlanta, Engr.

Fla., Jacksonville—The Atlantic National Bank will install a steam heating plant in the 1-story, 50 x 100 ft. bank which it plans to build. Total estimated cost, $100,000. Mowbray & Uffinger, 56 Liberty St., New York City, Engr.

Ohio, Akron—The Goodyear Tire & Rubber Co., Market St., will install a steam heating plant in the 4-story welfare building which it plans to build. Total estimated cost, $100,000. Walker & Weeks, 1900 Euclid Bldg., Cleveland, Arch.

Ohio, Cleveland—The Cleveland Automobile Co., East 131st St. and St. Clair Ave., plans to build a 4-story boiler house on London Rd. Estimated cost, $100,000. E. McGeorge, 1900 Euclid Ave., Arch.

Ohio, Cleveland—The Cream Cone Machine Co., 1836 Euclid Ave., has awarded the contract for the construction of a 3-story, 60 x 100 ft. factory on East 59th St. and Hough Ave. to the A. A. Lane Construction Co., 1836 Euclid Ave. A steam heating plant will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—Paul Bros., Citizens' Bldg., will install a steam heating system in the 11-story office building which they plan to build on East 6th St. and Vincent Ave. Total estimated cost, $750,000. G. A. Grieble, Sloane Bldg., Arch.

Ohio, Waverly—The city has appropriated $11,000 for all necessary electrical equipment for lighting the town. Address the City Clk.

Ind., Attica—The Neal Gravel Co., Indianapolis, plans to double the capacity of its present gravel output which will necessitate the purchase of new engines, boilers, crushers, screeners, gravel removing equipment and possibly a new steam shovel.

Ind., Vevay—The Board of Commissioners plan to install a complete steam heating system in Court House.

Mich., Detroit—The Alfred Street Jewish Congregation will install a steam boiler in the 2-story, 55 x 76 ft. synagogue which it plans to build on Alfred St. Total estimated cost, $50,000. R. Finn., 1144 David Whitney Bldg., Arch.

Mich., Detroit—H. Kramer & Sons, 1697 Gratiot Ave., will install a complete steam heating plant consisting of boiler, fans, motor driven air compressor, etc., in the 2-story, 80 x 230 ft. theatre and stores which it plans to build on Michigan Ave. between Bushey and Greusel Ave. Total estimated cost, $250,000. C. H. Crane and E. G. Kiehler, 2325 Dime Bank Bldg., Archts.

Mich., Detroit—St. Ambrose Parish, Wayburn Ave., will install complete steam heating apparatus in the 2-story, 75 x 100 ft. school which it plans to build on Wayburn Ave. and Alter Rd. Estimated cost, $100,000. Donaldson & Meier, 1314 Penobscot Bldg., Arch.

Ill., Chicago—The Fourteenth Church of Christ Scientist, c/o N. M. Dunning Arch., 310 South Wabash Ave., will install a steam heating plant in the 1-story, 105 x 140 ft. church which it plans to build on Pauline and Sunnyside Ave. Total estimated cost, $175,000.

Ill., Chicago—Schmidt, Garden & Martin, Archts., 104 South Michigan Ave., are receiving bids for the construction of a 3-story ice factory on Lake Park Ave. and 24th St. for the Hydrox Co., 3543 Normal Ave.

Ill., Chicago—The Sixteenth Church of Christ Scientist, 1700 Lunt Ave., will install a steam heating plant in the 1-story, 100 x 160 ft. church which it plans to build on Ashland and Kenilworth Ave. Total estimated cost, $200,000. H. S. Cheney, 208 South La Salle St., Arch.

Ill., Forest Park—Carelin & Manos, c/o O. P. Speyer, Arch., 6507 Greenview Ave., Chicago, will install a steam heating plant in the 3-story, 75 x 125 ft. theater, store and apartment which they plan to build on Madison and Harlem Ave., Total estimated cost, $150,000.

Wis., Kiel—The village is in the market for a deep well pump, a 35 hp. electric motor and air compressors for power plant.

Wis., Wyocena—The Columbia County Electric Light & Power Co. will install motors for running an electric feed and flour mill. Address J. Figor, Jr.

Minn., Altura—The Power Engineering Co., 510 Corn Exchange, Minneapolis, plans to build a light and power plant here, to supply the villages and towns. Estimated cost, $300,000.

Minn., Duluth—The Board of Education, Glencoe Bldg., will install a steam heating and ventilating system in the school which it plans to build on Riverside Townsite. Total estimated cost, $110,000. C. A. Bromson, Secy. Croft & Boerner, Lansdale Bldg., Engr.

Minn., Minneapolis—The Northwestern Catalogue Co., 800 Phoenix Bldg., will install a steam heating plant in the 4-story, 100 x 100 ft. warehouse which it plans to build. Total estimated cost, $100,000. Long, Lamoreaux & Long, 1028 Andrus Bldg., Arch.

Mo., Carondolet (St. Louis, P. O.)—The Mineral Refining & Chemical Corp. will receive bids about June 1 for the construction of a paint and pigment plant on the Mississippi River front. Plans include power plant, packing plant, etc. Estimated cost, $2,500,000. M. Alayo, Vice-Pres.

Mo., St. Louis—The C. Nelson Manufacturing Co., 2300 Division St., is in the market for several electric motors, planers, saws and woodworking machinery.

Cal., Redwood—The city plans election soon to vote on bonds for the construction of 7 bridges, a sewage pumping plant and a macadam road leading to the pumping station. C. E. Dimmick, City Engr.

N. S., Clarks Harbour—The Town Council is having plans prepared for the installation of an electric light plant. Estimated cost, $60,000.

Que., Three Rivers—The Canadian Pacific R.R., Windsor St., Montreal, will soon receive bids for electrifying branch line from Three Rivers to Shawenegan Falls and Grand Mere. J. M. Fairbairn, Ch. Engr.

Ont., Galetta—The Galetta Electric Power Co., Arnprior, plans to extend their lines from Galetta to Arnprior. J. R. Dodd, Arnprior, Gen. Supt.

Ont., London—A. Deviney, St. Marys, is in the market for a steam engine, boiler, etc., to be installed in the flax mills which he plans to build. Total estimated cost, $50,000.

Ont., Sarnia—W. D. Ferguson and J. McCutcheon have purchased a building at 313 Front St., and will remodel same for a cold storage plant. Estimated cost, $25,000.

Ont., Welland—The city plans to build an ice plant. Estimated cost, $35,000.

CONTRACTS AWARDED

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a pump house for electric remote control gasoline system at the Naval Air Station here, to C. Mead & Co., 38 Park Row, New York City. Estimated cost, $1,664. Noted Apr. 29.

N. Y., Westfield—Armour & Co., 208 South La Salle St., Chicago, Ill., has awarded the contract for rebuilding its 3-story, 130 x 200 ft. factory and 54 x 54 ft. power house, destroyed by fire, to the Black Construction Co., 20 West Jackson Blvd., Chicago, Ill. Estimated cost, $210,000.

Md., Baltimore—The city has awarded the contract for furnishing and erecting a 30,000,000 gallon turbo-centrifugal pump and auxiliary equipment to be installed at the Mount Royal Pumping Station, North Ave. and McMechen St., to the Worthington Pump & Machine Corp., 115 Broadway, New York City. Estimated cost, $26,258. Noted Dec. 24.

Fla., Pensacola—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for power plant improvements here, to the Carroll Electric Co., 714 12th St., Washington, D. C. Estimated cost, $54,500 (150 days).

Ohio, Cincinnati—The Dolly Varden Chocolate Co., 411 Laurel St., has awarded the contract for the construction of a 6-story, 53 x 100 ft. candy factory, to the Ferro Concrete Construction Co., Richmond and Harriet St. A 60-ton carbon-dioxide refrigerating system and a 150 hp. boiler will be installed in same. Estimated cost, $80,000.

Minn., Cloquet—The Board of Education has awarded the contract for installing a heating system in the high school, here, to H. Gazett, 423 Superior St., Duluth. Estimated cost, $28,600.

Opportunities!

CONTRACTS

Contracts to be let for furnishing Boilers, Stokers and Drivers.

POSITIONS

For Mechanical and Electrical Engineers, Superintendents, Chief Engineers, Salesmen, etc. —and men for like positions.

TO SELL TO BUY

Advertisements of equipment wanted to purchase —of equipment offered for sale at bargain prices.

All these "Opportunities" appeared in *last* week's issue.
You will find those offered *this* week on pages 83 to 90.

PRICES - MATERIALS - SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in.		70c. per ft.
Common, 2½-in.		40%

	Air		
	First Grade	Second Grade	Third Grade
½-in. per ft.	$0.50	$0.35	$0.25

Steam—Discounts from List

First grade..... 30% Second grade.....40% Third grade....40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 60% Best grade..... 35%
Standard..... 50%

Note—Above discounts apply on new list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	45%	35%
St. Louis	45%	50%
Chicago	45%	40%
Birmingham	35%	35%
Denver	35-5%	30%

RAWHIDE LACING—20% for cut; 45c. per sq. ft. for ordinary.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.60
Duck and rubber for piston packing	1.00
Flax, regular	1.20
Flax, waterproofed	1.60
Compressed asbestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.80
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.20
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure..... List

For low-pressure heating and return lines { 4-ply..... 58% off; 3-ply..... 60% off; 2-ply..... 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Pittsburgh	Chicago	St. Louis	Birmingham	Denver
Cup	7	9	5½	7.2	8½	14½
Fiber or sponge	8	10	6	13	8½	18
Transmission	7	9	6	13	8½	20
Axle	4½	6	4	4.75	4½	5½
Gear	4½	9	4½	7.5	8½	8
Car journal	22(gal.)	21 (gal.)	3½	4.9	8½	8

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	11.00 to 13.00	13.00	16.50	12.00 to 16.50
Colored mixed	8.50 to 12.00	12.00	13.00	11.50 to 14.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$52.00	$58.00
Chicago	48.00	50.00

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw in barrels	$1.55	$1.55	$1.68	$1.65	$1.66	$1.65
5-gal. cans	1.70	1.65	1.85	1.80	1.86	1.75

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13.00	14.50	11.25	11.50	13.00	10.50
25- and 50-lb. kegs	13.25	14.75	11.50	11.75	13.25	10.75
12½-lb. keg	13.50	15.00	11.75	11.00	13.50	11.00
1-lb. cans	15.00	16.50	13.25	13.00	15.00	13.00
5-lb. cans	16.00	17.50	13.25	13.50	16.00	13.00

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½%.

AMMONIA—Price per pound in St. Louis for 26 deg. U. S. P., 100-lb. carboys, is 11c.; in 1000-lb. drums, 9c.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	40%	60-5%	45%
Tinned	30%	60-5%	40%

Boiler rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York....$6.25 Cleveland...$4.75 Chicago...$4.72 Pittsburgh... 4.65

Structual rivets, same sizes:

New York....$6.25 Cleveland...$4.85 Chicago...$4.82 Pittsburgh...$4.75

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$120.00 at Chester, Penn.
Chrome cement	net ton	65.00 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	40-30 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	38-48 at Clearfield, Penn.
Magnesite, dead burned	net ton	32.50 at Chewalah, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	net ton	45-55 at Mt. Union, Penn.

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—Fire Clay, $35 to $50.
Birmingham—Fire clay, $45; silica, $50; magnesite, $85; chrome, $95.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

FUEL OIL — Domestic light, 22-26 deg., Baume, is 10½c. per gal. in St. Louis.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	87.00	90.00	79.00	90.00	75.00	90.00
Commercial	42.00	50.00	18.50	30.00	15.00	30.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$25.50-30	$15.00
Cleveland	20.00	15.00
Chicago	16.50	15.00

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 15c. per lb.

POLES—Prices on Western red cedar poles:

	New York	Chicago	Denver	San Francisco
6 in. by 30 ft.	$5.82	$5.17	$4.55	$5.17
7 in. by 30 ft.	7.65	6.85	6.10	6.85
7 in. by 35 ft.	11.10	10.00	8.95	10.00
8 in. by 35 ft.	12.65	11.35	10.10	11.35
7 in. by 40 ft.	12.85	11.50	10.20	11.50
8 in. by 45 ft.	18.90	16.90	15.00	16.90
8 in. by 50 ft.	22.65	20.30	18.00	20.30

10c. higher freight rates on account of double loads.
For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft.	$9.00
12-in. butts, 6-in. tops, length 30-40 ft.	11.50
12-in. butts, 6-in. tops, length 41-50 ft.	12.50
14-in. butts, 6-in. tops, length 51-60 ft.	21.00
14-in. butts, 6-in. tops, length 61-71 ft.	23.50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh; basing card of Jan. 1, 1919, for steel pipe and for iron pipe:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
⅛, ¼, and ⅜	50½%	24%	⅜ to 1½	39½%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			

LAP WELD

2	50½%	38%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	46½%	26%	¾ to 1½	39½%	24½%
½	51½%	39%			
¾ to 1½	55½%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48%	37½%	2	33½%	20½%
2½ to 4	51%	40½%	2½ to 4	35½%	23½%
4½ to 6	50%	39½%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
⅛ to 3 in. steel butt welded	47%	31%	46½%	31%	57½%	44%
2½ to 3 in. steel lap welded	42%	27%	42½%	27½%	51½%	41%

Malleable fittings. Class B and C, from New York stock sell at list + 12½%.
Cast iron, standard sizes, 10% off.

BOILER TUBES — The following are the prices for carload lots, f. o. b Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	40½	3½ to 4½ in.	15½
2½ to 3¼ in.	30½	3 to 3¼ in.	1
2¼ in.	24	2½ to 2¾ in.	+ 1
1¼ to 2 in.	19½	2 to 2¼ in.	+16
		1¾ to 1¼ in.	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in.	$327	1¾ in.	$207
1¼ in.	267	2 to 2¼ in.	177
1½ in.	257	2¼ to 3¼ in.	167
1¾ in.	207	4 in.	187
		4½ to 5 in.	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

ELECTRICAL SUPPLIES

General Decline Expected, To Be Noted in Next Issue

ARMORED CABLE—

B.&S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104.00	$138.00	$164.00	$222.00
No. 12 solid	135.00	170.00	211.00	290.00
No. 10 solid	185.00	235.00	255.00	325.00
No. 8 stranded	235.00	325.00	345.00	450.00
No. 6 stranded	370.00	472.00	625.00	.....

From the above lists discounts are:

	Net List
Less than coil lots	
Coils to 1,000 ft.	10%
1,000 ft. and over	15%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready

	Each, Net
Less than 12	$0.40
12 to 50	.38
50 to 125 (bbl.)	.35
125 (bbl.) or over	.32

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per 100 for couplings and elbows:

Size, In.	Conduit Black 1,000 Ft. and Over	Conduit Galvanized 1,000 Ft. and Over	Elbows Black 100 and Over	Elbows Galvanized 100 and Over	Couplings Black 100 and Over	Couplings Galvanized 100 and Over
⅜	$71.15	$76.25	$17.04	$18.18	$5.38	$5.74
½	71.15	76.25	17.04	18.18	6.28	6.70
¾	93.96	100.86	22.43	23.93	8.97	9.57
1	138.39	149.09	33.19	35.41	11.66	12.44
1¼	187.91	201.71	42.62	45.31	16.10	17.12
1½	224.68	241.18	56.82	60.62	19.89	21.15
2	302.29	324.49	104.17	110.77	26.52	28.20
2½	477.95	513.05	170.46	181.26	37.88	40.28
3	625.00	670.91	454.56	483.36	56.82	60.42
3½	779.24	834.44	1,003.82	1,067.42	75.76	80.56
4	945.03	1,010.43	1,160.08	1,233.57	94.70	100.70

5% cash 10 days.

From New York Warehouse—Less 5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, ⅜ in., 100 ft. Standard lengths flexible, ½ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.
⅜	250	$0.05½
½	250	.06
⅝	250	.09
¾	200	.12
⅞	200	.15
1	150	.18
1	100	.25
1¼	100	.33
1½	Odd lengths	.40
2	Odd lengths	.55

Coils..... 60% off
Less coils, 50% off

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T. P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$18.00
No. 16 cotton twisted	24.00
No. 18 cotton parallel	25.00
No. 16 cotton parallel	32.00
No. 18 cotton reinforced heavy	35.00
No. 16 cotton reinforced heavy	42.00
No. 18 cotton reinforced light	30.00
No. 16 cotton reinforced light	36.00
No. 18 cotton Canvasite cord	29.00
No. 16 cotton Canvasite cord	35.00

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	.90
110-amp. to 200-amp.	25	2.00
225-amp. to 400-amp.	25	3.60
2-amp. to 600-amp.	10	5.50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package 30%
1-5th to standard package 40%
Standard package 52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$4.75 C
0-30 ampere, less than standard package	6.00 C

LAMPS—Below are present quotations in less than standard package quantities.

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shape Bulbs Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.38	100	75	$0.70	$0.75	50
15	.35	.38	100	100	1.10	1.15	24
25	.35	.38	100	150	1.65	1.70	24
40	.35	.38	100	200	2.20	2.27	24
50	.35	.38	100	300	3.25	3.35	24
60	.40	.45	100	400	4.30	4.45	12
100	.85	.92	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Hubbell, porcelain No. 5406, standard package 250	$0.24
Hubbell composition No. 5467, standard package 50	.32
Benjamin swivel No. 903, standard package 250	.20
Hubbell current taps No. 5638, standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12.00	$14.00	$13.90	$25.00
12	13.25	15.70	18.05	30.70
10	18.30	21.00	23.85	41.50
8	25.54	28.60	32.70	56.77
6	.....	.....	51.40	.....
4	.....	.....	70.00	.....
2	.....	.....	101.80	.....
1	.....	.....	131.86	.....
0	.....	.....	160.00	.....
00	.....	.....	193.50	.....
000	.....	.....	235.20	.....
0000	.....	.....	288.60	.....

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

No.	Denver Single Braid	Denver Double Braid	Denver Duplex	St. Louis Single Braid	St. Louis Double Braid	St. Louis Duplex	Birmingham Single Braid	Birmingham Double Braid	Birmingham Duplex
14	$11.00	$14.50	$30.40	$16.00	$21.00	$33.00	$10.95	$15.25	$27.75
10	19.20	25.70	49.00	27.20	31.00	69.00	20.25	24.25	46.90
8	26.95	34.25	67.00	38.00	42.00	78.00	27.60	32.60	.....
6	43.90	46.20	.....	.....	65.00	130.00	48.25	54.75	.....
4	62.35	65.15	.....	.....	93.00	.....	66.90	73.75	.....
2	92.60	96.25	.....	.....	140.00	.....	96.00	104.50	.....
1	120.95	125.20	.....	.....	182.00	.....	121.00	136.40	.....
0	164.80	164.80	.....	.....	242.00	.....	169.00	174.60	.....
00	.....	203.35	.....	.....	290.00	.....	203.50	214.00	.....
000	.....	248.40	.....	.....	360.00	.....	246.00	257.50	.....
0000	.....	302.55	.....	.....	435.00	.....	295.50	358.50	.....

Pittsburg—34c. base; discount 50%

SOCKETS, BRASS SHELL—

¾ In. or Pendant Cap. Key, Each	Keyless, Each	Pull, Each	¾ In. Cap Key, Each	Keyless, Each	Pull, Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package +20%
1-5th to standard package +10%
Standard package −15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	36c. lb.
No. 18 B.&S. regular 1-lb. coils	37c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 50c. lb., 100 lb. lots	48c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb.
Soldering paste, 2 oz. cans Nokorode	$1.20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	.70	1.06	1.60	2.120
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.3
200	4.40	6.76	10 14	13.50

Discounts:

Less than $10.00 list value	+ 5%
$10 to $25 list value	— 8%
$25 to $50 list value	—15%
$50 to $200 list value	—20%
$200 list value or over	—25%